DOCUMENT RESUME

ED 161 733 SE 025 199

TITLE	National Environmental/Energy Workforce Assessment, Phase II, Post-Secondary Education Profile: Composite I (Environmental Engineering/Health).
INSTITUTION	National Field Research Center Inc., Iowa City, Iowa.
SPONS AGENCY	Environmental Protection Agency, Washington, D. C.
PUB DATE	78
GRANT	EPA-T-900591
NOTE	584p.; For related documents, see SE 025 197-211; Photographs may not reproduce well
EDRS PRICE	MF-$1.16 HC-$31.47 Plus Postage.
DESCRIPTORS	Acoustics; Air Pollution Control; Curriculum; Employment; Energy; Engineering; *Environmental Education; Graduate Study; Health Education; *Higher Education; *National Surveys; Pesticides; *Postsecondary Education; *Program Descriptions; Radiation; *Science Education; Sciences; Waste Disposal; Water Resources
IDENTIFIERS	Solid Wastes; Waste Water Treatment; Water Treatment

ABSTRACT

This report presents a summary of a survey of education and training programs in junior colleges, vocational/technical training institutes, community colleges, four-year colleges, and universities as well as other training institutions. It represents a sample, only, of the various programs available nationwide. The programs presented here have a focus or emphasis on two or more environmental areas or are environmentally-related, but are not specific to any one area. This report includes engineering/health programs. Ninty-three programs were surveyed in 32 states. Statistics are given on: (1) states, institutions, programs, and degrees; (2) enrollment, graduates, and faculty; (3) curricula; (4) research funding and sources of financial support; and (5) employment. (BB)

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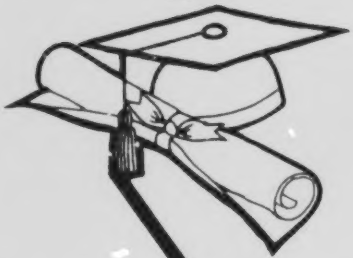

Post Secondary Education Profile

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COMPOSITE I

(Environmental Engineering/Health)

Phase II
Of A National Environmental/Energy Workforce Assessment

Conducted by:

NATIONAL FIELD RESEARCH CENTER, INC.
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SE 025 199

NATIONAL ENVIRONMENTAL/ENERGY WORKFORCE ASSESSMENT

PHASE II

POST-SECONDARY EDUCATION PROFILE

COMPOSITE I

(Environmental Engineering/Health)

Conducted by:

NATIONAL FIELD RESEARCH CENTER, INC.

Under Grant from:

UNITED STATES

ENVIRONMENTAL PROTECTION AGENCY

Grant #T900591

1978

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ACKNOWLEDGEMENT

Appreciation is extended to the many individuals, institutions, and organizations who generously contributed to the success of this national project. Of particular import are those contact persons listed in the program summaries. Their time and assistance in preparation, input and review represents the foundation upon which the National Environmental/Energy Workforce Assessment - Phase II rests.

Sincere appreciation is **expressed** to those persons within the United States Environmental Protection Agency, Office of Federal Activities, who provided guidance and direction throughout the term of the project: Mr. J. Donald Cook, Project Officer; Mr. Joseph McCabe, and Mr. Michael Moore. Special thanks are also extended to Mr. Tahlman Krumm, Ohio State University; and to Dr. Aleksander S. Vesic′, Duke University (North Carolina).

Gratitude must be expressed to the many individuals and organizations from the private sector who were most generous in their contribution to this project. Their openness and responsiveness reflect their concern regarding the training of our environmental workforce and their critical role in that effort.

REVIEW COMMITTEE

A special word of acknowledgement is extended to the following people who graciously gave of their time, knowledge and experience in order to review and comment on the information included in this volume. The efforts of this national committee were particularly insightful, and in general have been incorporated into the final report.

It must be pointed out that in all cases the individuals acknowledged below were asked only to review and comment on the material contained in the volume and to express their views regarding the representativeness of the material presented. They were not asked to endorse either the volume or the study in general, and the inclusion of their name on this list should not be considered an endorsement since such was not the intent.

In light of numerous responsibilities, it is especially important to note that these persons responded within very strict time constraints. Such a pattern reflects positively on both the individuals and the institutions and organizations which they represent.

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FOREWORD

Information for this report was largely compiled from on-site interviews with professionals in post-secondary institutions throughout the United States. On-site interviews were supplemented by telephone and/or mail contact to clarify and revalidate the data. This report presents a summary of programs in junior colleges, vocational/technical training institutes, community colleges, four-year colleges, and universities as well as other training institutions. Programs are representative of all levels from academic certification through doctoral degrees. The environmental pollution control areas of air, noise, pesticides, potable water, radiation, solid waste, wastewater and energy were surveyed.

This study was conducted for the United States Environmental Protection Agency by the National Field Research Center, Inc. of Iowa City, Iowa, with field offices located in Atlanta, Georgia; Denver, Colorado; and Washington, D.C.

NATIONAL ENVIRONMENTAL/ENERGY WORKFORCE ASSESSMENT

PHASE II

POST-SECONDARY EDUCATION PROFILE

COMPOSITE SUMMARY

THE FOLLOWING PAGES PRESENT AN OVERVIEW, IN SUMMARY FORM, OF BOTH VOLUMES OF THE COMPOSITE REPORT. WHILE THE SUMMARY SYNOPSIZES ENGINEERING/HEALTH AND EDUCATION/ECOLOGY PROGRAM AREAS, INTERESTED READERS ARE ENCOURAGED TO REFER TO BOTH COMPOSITE VOLUME I (ENGINEERING/HEALTH) AND COMPOSITE VOLUME II (EDUCATION/ECOLOGY) FOR A MORE IN-DEPTH PRESENTATION OF PROGRAMS.

The Composite category accomodates those programs whose focus, structure, curriculum content, and specialized options indicate an overlapping emphasis in two or more environmental areas surveyed in Phase II or whose emphasis is environmentally related but not specific to any one area. This category is further divided into Engineering/Health and Education/Ecology sections; the former reflects a more technological emphasis while the latter integrates coursework in the natural, physical, and social sciences. This conceptual split in the composite category was intended to generate a more interpretable data base; however, the differences between the two sections are not substantial.

A. STATES, INSTITUTIONS, PROGRAMS, AND DEGREES

The Post-Secondary Education Profile (Phase II) surveyed 93 Engineering/Health programs in 32 states and 37 Education/Ecology programs in 17 states. In total, these programs represent a wide spectrum of degree offerings--from the diploma to the doctorate--and curriculum options. Given that 49 of the 93 institutions included in the composite sections offer more than one degree and 16 offer more than one environmental program, any list of schools surveyed in the Post-Secondary Inventory quantitatively represents many more curriculum opportunities than it suggests. The following table lists the number of programs surveyed by degree in the Composite category. For purposes of this summary, the Engineering/Health and Ecology/Education programs are combined.

COMPOSITE DEGREES, PROGRAMS, AND STATES

Degree	Number of Programs	States	
Certificate (graduate level)	1	Alabama	New York
		Alaska	North Carolina
Diploma	1	Arkansas	Ohio
		California	Oklahoma
Associate	12	Connecticut	Pennsylvania
		Delaware	South Carolina
Bachelors	38	District of Columbia	
		Florida	Tennessee
Masters	18	Georgia	Texas
		Indiana	Utah
Environmental		Iowa	Virginia
Engineering	1	Kansas	Washington
		Kentucky	West Virginia
Multiple Degree		Louisiana	Wisconsin
Cert/Asso/Bach/Mast/Doct	1	Maine	
Associate/Bachelors	2	Maryland	
Bachelors/Masters	11	Massachusetts	
Bachelors/Masters/Doctoral	15	Michigan	
Masters/Doctoral	29	Minnesota	
Masters/Doctoral/Engineer	1	New Jersey	
TOTAL	130	33	

B. ENROLLMENT STATISTICS AND GRADUATES

National summaries of enrollment and graduates per annum for the Composite programs surveys are reported in the following table. These data indicate that approximately three-fifths (58%) of the graduates in the Composite programs are awarded degrees at the bachelors level. The relative scarcity of sub-baccalaureate programs may in part be due to the four-year program requirements normally mandated in engineering and teacher training programs. Enrollment statistics indicate that 54%

NATIONAL COMPOSITE PROGRAMS

ENROLLMENT PROFILE SUMMARY

Degree	Enrollment Full-time	Enrollment Part-time	Graduates Average # Per Year	Enrollment Change by Program Up	Enrollment Change by Program Down	Enrollment Change by Program Stable
Diploma	14	0	8	0	1	0
Associate	329	70	138	3	4	6
Bachelors	6,206	376	1,586	32	3	24
Masters	1,567	660	905	21	8	42
E.E.	4	12	9	0	1	1
Doctoral	279	76	104	10	5	31
TOTAL	8,399	1,194	2,750	66	22	104

of the Composite programs are experiencing stable enrollment and 34% are sustaining growth.

Percentages of in-state/out-of-state/foreign students show a fairly linear increase by degree level. That is to say, graduate programs have higher numbers of out-of-state and foreign students than undergraduate programs. This result is not surprising if one considers the capacity of the graduate programs--with their research facilities and tuition remission and assistantship plans--to attract students from a wider geographical radius.

Recruitment techniques are relatively standard across these composite programs and include posters, brochures, visits to local high schools, and campus career days. Those programs with extensive facilities, traineeships, or other curricular or financial attractions find such inducements facilitate recruitment. The effectiveness of any one method is difficult to assess across programs and is undoubtedly the function of many intervening variables.

C. FACULTY

A total of 992 (62%) full and 610 (38%) part-time members serve the 130 composite training programs surveyed. Of these, 832 (68%) full and 383 (32%) part-time faculty are associated with engineering/health programs and 169 (43%) full and 227 (58%) part-time faculty are working in education/ecology programs. In several programs, a number of departments supply faculty to teach various courses in the composite programs.

When asked how they remain current in their field, faculty responses were largely the same--journals, professional meetings, and consulting. A number of contact persons noted the difficulty of keeping abreast of the rapid changes in the environmental field and observed the need for periodic, easily obtainable up-dates on environmental research and regulations.

D. CURRICULA

Programs in the Engineering/Health section prepare students in at least two of the eight environmental areas surveyed in Phase II (air, energy, noise, pesticides, potable water, radiation, solid waste, and wastewater). The emphasis of the programs is primarily technical and/or scientific and, as reflected in the section heading, geared to environmental engineering and environmental health coursework. The Education/Ecology programs train students for social, educational, political, ecological, managerial, and sytems positions within the environmental workforce. The curricular emphases of both sections are not easily isolated, and the assignment of programs to a particular section is subjective.

Curriculum flexibility, as measured by the amount of time needed to implement a new course or program, gives some indication of the capacity of the educational community to meet changing employment needs. In response to questions regarding this flexibility, contact persons reported that new courses can usually be implemented in one month to one year while program changes may take slightly longer. Answers to these questions were often conditional and dependent on the availability of faculty time and financial resources, departmental and institutional support, and the preparation readiness of course syllabi and materials.

Contact persons made several comments on existing curriculum materials and suggestions for improving instructional aids. They noted that training materials are often "too specific or too general" or "too sophisticated for two-year training programs." Contact personnel asked for curriculum aids that integrate Environmental Studies subjects, more visual aids, and more laboratory equipment. There is some concern that some equipment purchased with federal grant monies must now be returned to the government upon completion of the grant, thus limiting the continuation of research projects.

A concern of professionals in the environmental workforce is that graduates are weak in communication and financial management skills.

Engineering/Health and Education/Ecology program personnel surveyed in Phase II basically agree with this assessment but argue that the same concern applies to all students regardless of discipline. Programs typically require some communication training (writing and speaking) in both formal and informal settings. Financial management skills are usually developed in less structured ways than actual coursework, and according to some contacts, are not necessary prerequisites for submanagerial employment.

To provide students with a practical working experience related to their classroom and laboratory training, 29% of the Engineering/Health and 59% of the Education/Ecology degree programs offer internships or applied study terms. These experiences not only prepare students for real-world employment but may facilitate job placement. Salaries paid for work under these instructional programs are also a means of financial aid.

E. RESEARCH FUNDING AND SOURCES OF STUDENT FINANCIAL SUPPORT

The financial stability of environmental programs is often a key to their success or demise. Monies for research and student financial aid enable programs to attract faculty and students. Federal and state agencies, private corporations, regional study commissions, and other entities provide important research funding to many of the programs surveyed in Phase II. Curriculum changes, additional faculty lines, laboratory materials, and salary increments cost money; and environmental programs are looking more and more to the federal government for support.

Student financial aid packages typically include scholarships; federal, state, and campus loan programs; college work study; and part-time employment outside the university. A majority of graduate students in many of the programs are employed by their departments as teaching or research assistants or as support personnel on program grants or contracts. Traineeships, such as those from the Environmental Protection Agency and the National Institute of Occupational Safety and Health, are an important means of support for those programs fortunate enough to receive them; many other contacts note the negative impact the loss of these traineeships has had on the stability of their programs.

F. EMPLOYMENT

Contact personnel were asked what percentage of their program graduates are employed in industry, consulting, government, or other fields (teaching positions, etc.). The following tables summarize these results nationally.

Industry and government appear to draw greater numbers of Engineering/Health and Education/Ecology program graduates than do consulting firms and various educational institutions. The high percentage of graduates entering government work is not surprising given the emphasis placed on environmental regulation, assessment, and protection by the public sector. Likewise, government mandates have forced industry to take steps in combating pollution and precipitated employment opportunities in this area. Declines in public school enrollment and fiscal constraints at all levels have contributed to decreasing numbers of jobs in the educational community.

COMPOSITE PROGRAMS

NATIONAL EMPLOYMENT PROFILE

Degree	Private Sector Industry	 Consulting	 Total	Government	Other
Diploma	1%	0%	1%	99%	0%
Associate	32%	11%	43%	54%	2%
Bachelors	34%	12%	46%	42%	11%
Masters	26%	23%	49%	38%	13%
E.E.	58%	11%	69%	27%	3%
Doctoral	27%	28%	55%	31%	14%
TOTAL	31%	16%	47%	41%	12%

In an attempt to identify more specifically those occupations which Engineering/Health and Education/Ecology graduates are qualified to fill, survey participants were asked to check on a prepared form those jobs that graduates of a given degree are trained to assume. Occupations most often cited were:

Composite

Degree Level	Occupations
Certificate	Air Pollution Control Technician Environmental Monitoring Specialist Regulatory Specialist Sanitary Technician Solid Waste Collection Operator Vector Control Specialist
Associate	Biological Technician Environmental Tester/Analyst Sanitary Technician
Bachelors	Ecologist Environmental Engineering (Water Pollution Control) (Water Resources) Environmental Science Technician Industrial Waste Inspector
Masters	Chemist Environmental Engineer (Water Pollution Control) (Water Resources) Pollution Control Specialist Sanitary Engineer
Environmental Engineering	Air Pollution Analyst Air Pollution Control Engineer Environmental Control Engineer Environmental Engineer (Water Pollution Control) (Water Resources)
Doctoral	Aerosol Physicist Aquatic Biologist Bacteriologist Chemist Environmental Engineer (Water Pollution Control) Microbiologist Pollution Control Specialist

PROJECT BACKGROUND

Photo reprinted from the University of Wisconsin, Madison Oceanography and Limnology Catalog

PROJECT BACKGROUND

OVERVIEW:

In late 1975, Congress acknowledged the growing national concern for the preservation and conservation of our national resources with a direct inquiry into the availability and readiness of our environmental workforce. That inquiry has taken the form of a three-year, three-phase National Environmental/Energy Workforce Assessment, currently being conducted by National Field Research Center under the direction of the U.S. Environmental Protection Agency. In keeping with the objective of the assessment, this three-phase national effort directs itself at environmental/energy workforce needs, national educational preparedness, and the functional relationship between the two.

PHASE I:

Phase I of the National Environmental/Energy Workforce Assessment focused upon the development of "workforce demand projections" through 1982 for all public environmental agencies. This on-site assessment, which was carried out in all 50 states, Puerto Rico and the Virgin Islands, culminated in a numerical profile of the growth patterns and workforce needs at the national and state levels. Stratification of the overall definition of "environmental occupation" into seven distinct vocational areas enhanced even further the applicability of the results. In addition to this public sector workforce assessment, Phase I included an overview analysis of private sector needs (through an adjunct mail survey of selected businesses and industries) and a brief review of selected environmental educational programs.

Phase I was completed in May, 1977. The 70-volume final report included:

* National Abstract	(1)
* National Legislation	(1)
* Regional Assessments	(10)
* State Assessments (including D.C., VI and PR)	(53)
* Business and Industry Assessment	(1)
* National Summary	(4)

PHASE II:

Phase II of the National Environmental/Energy Workforce Assessment was structured around an intensive on-site inventory of representative environmental educational offerings on a national scale. The primary objective of this project has been to collect and aggregate data on training and educational programs in both the post-secondary education field and in the private sector and to do so by environmental area. Specifically, the study was designed to provide an overview of environmentally related post-secondary education programs, their program structure, representative course offerings, employment history of the graduates, and the faculty structure. Additionally, information was to be collected on program requirements and program projections.

Initially, opportunities to nominate programs for inclusion in this on-site review process was given to the Environmental Protection Agency and its program officers and regional personnel both through the

Project Officer and via direct mail requests; all state departments of education; state environmental agencies and selected media-specific associations. These nominations were supplemented by a direct review of institutional catalogs, information obtained during the first year's on-site activities, and a review of other published sources of information regarding degree programs in environmental areas. These sources are included in Appendix III - Selected Bibliography.

Following their initial development, the lists of nominees were forwarded to the program officers for suggestions regarding additions or deletions. Next, letters were written to those nominated institutions seeking their support and cooperation in the on-site review process. Several programs, some of which were highly recommended, declined the opportunity to participate giving reasons varying from lack of time to the fact that the program being inquired about no longer existed, to outright refusal to cooperate with any government study. These institutions were deleted from the final on-site process. The remainder were included in the study and are shown in Table 1 of each volume. Selection of the sample for the private sector is discussed in depth in that particular volume.

In preparation for the on-site interviews, appropriate persons were contacted in the institution involved and were given a background description of the study, a suggested timetable for the interview process and were told what kind of information was being sought. This was all done in an effort to keep the time involvement of the individual contact persons at a minimum. During the actual on-site interview, generally lasting around one hour, the information was collected, questions asked and answered, and further informational contacts identified. Following this process, each on-site interview was written up in the form of a Training Program Summary, which where time allowed, was returned to the contact person for critiquing prior to inclusion in the report.

Throughout this process, individuals and institutions were given assurance that this study was not an attempt to evaluate program offerings and every attempt has been made on the part of the writers to live up to this assurance. Inclusion in this report provides no assurances of quality, nor should a program's exclusion be consideration of the lack thereof. In many instances certain programs within an institution were not included while others were, primarily due to the determination of the sample - previously discussed. This too should not be viewed in any qualitative manner.

REPORT ORGANIZATION:

The final report, of which this volume is a part, consists of volumes depicting a training profile in each medium under consideration, namely,

Air
Energy
Noise
Pesticides
Potable Water
Radiation
Solid Waste
Wastewater
Composite
Business and Industry and Trade Associations

At the outset it should be pointed out that there are very few degree programs conveying degrees in a particular medium; rather, degrees are offered in various specialties which lend themselves to obtaining employment in one or more of these fields. Nonetheless, to obtain maximum utility for the funding agency, programs were reported in this fashion. The Composite section was necessitated by the number of programs offering course work in multiple fields and differing specializations resulting from course selection. For convenience in handling of the data Potable Water, Wastewater and Composite have been reported in multiple volumes because of the numbers involved. Although separated into volumes either by degree level of the programs involved, as in the case of Potable Water and Wastewater, or by content as in the case of Composite, persons interested in any of these fields would be well advised to review each of the volumes to assure more complete coverage.

Along with the standard introductory pages common to volumes of this nature, each volume contains sections on Project Background, Introduction (consisting of sections devoted to a description of the programs surveyed and covered in the volume), Project Commentary, and the Training Summaries along with the Appendices.

REVIEW PROCESS:

In addition to individual training summary reviews conducted by the persons initially interviewed, each volume has been reviewed internally, by persons in the Environmental Protection Agency and by a select group of review committee members. In the final instance, individuals met during the on-site process were nominated by interviewers for inclusion on the review committee, primarily as a result of their obvious expertise in the field and their evidenced interest in the project.

These persons were then contacted by mail or by telephone in an effort to determine their willingness to serve. The rather stringent timelines necessary to keep the project on course and to deliver the finished product as specified were also detailed. In excess of one hundred persons returned their volumes (out of a mailing of 120) and all but five of these provided usable responses. In these five instances either last minute job demands prevented them from carrying out the review in the short timelines, or (in two instances) individuals indicated that they wanted nothing to do with the process. This particular method of review provided a wealth of valuable information, suggestions for revision of specific elements, and general comments helpful in revising the final documents. In all cases an effort was made to seriously consider and incorporate reviewer suggestions. The persons on the various review committees are individually acknowledged in the front of the volume they reviewed.

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of Missouri, Columbia Bulletin 1977.

Photo reprinted from the
Northland College Catalog
1975-76

INTRODUCTION

INTRODUCTION

Phase II of the National Environmental/Energy Workforce Assessment Project was designed to survey the capability of the educational community to generate an environmental workforce. The resulting Post-Secondary Education Profile identified and gathered information concerning representative training programs in a variety of environmental areas: air, energy, noise, pesticides, potable water, radiation, solid waste, and wastewater. At the onset, it became readily apparent that some environmental programs do not fit neatly into any single category: they may fit more than one or none at all. Nonetheless, these programs produce environmentally aware and environmentally skilled graduates who then enter our national workforce. In order to include these unique or umbrella programs, a category labeled COMPOSITE was created.

Subsequent review of the structure, objectives and goals, and course requirements and descriptions for each composite program suggested the feasibility of further dividing these programs into two sections. The first volume--Environmental Engineering/Health--contains those programs which prepare students for predominately technical, engineering, or environmental health occupations. Curriculum options, areas of specialization or concentration, and coursework, by the very nature of the composite designation, reflect at least two of the environmental areas surveyed in this Workforce Assessment Project. The second section--Environmental Education/Ecology--contains programs that train students for social, educational, political, ecological, managerial, and systems positions within the environmental workforce. While students enrolled in these Education/Ecology programs may receive

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extensive technical training, their plans of study incorporate the social and behavioral sciences, resource management and policy, and training in the integration of disciplines in solving environmental problems.

The sectional placement of a given composite program was essentially based on a subjective assessment of that program's commonality with other programs in Engineering/Health and in Education/Ecology. As such, the identification of programs as either Engineering/Health or Education/Ecology is subject to question. The purpose of dividing these composite programs, however, was not to attain a high degree of inter-rater reliability but to permit a potentially more interpretable data set. For a more complete understanding of the type of programs included in each composite section, one should consult the individual program summaries contained in the two volumes titled Engineering/Health and the single volume titled Education/Ecology.

Given these definitional considerations, the survey responses from contact personnel in Environmental Education/Ecology programs regarding student enrollment and recruitment, employment and follow-up of graduates, research activity and support, faculty numbers, curriculum projections, and funding needs are presented and discussed in the pages that follow. Responses are compiled nationally, and by degree level. While sample size and sampling error limit the generalizability of these results, some attempt is made to summarize the general implications of the project for training programs in Environmental Education, Ecology, and related areas.

TABLE I

PARTICIPATING INSTITUTIONS

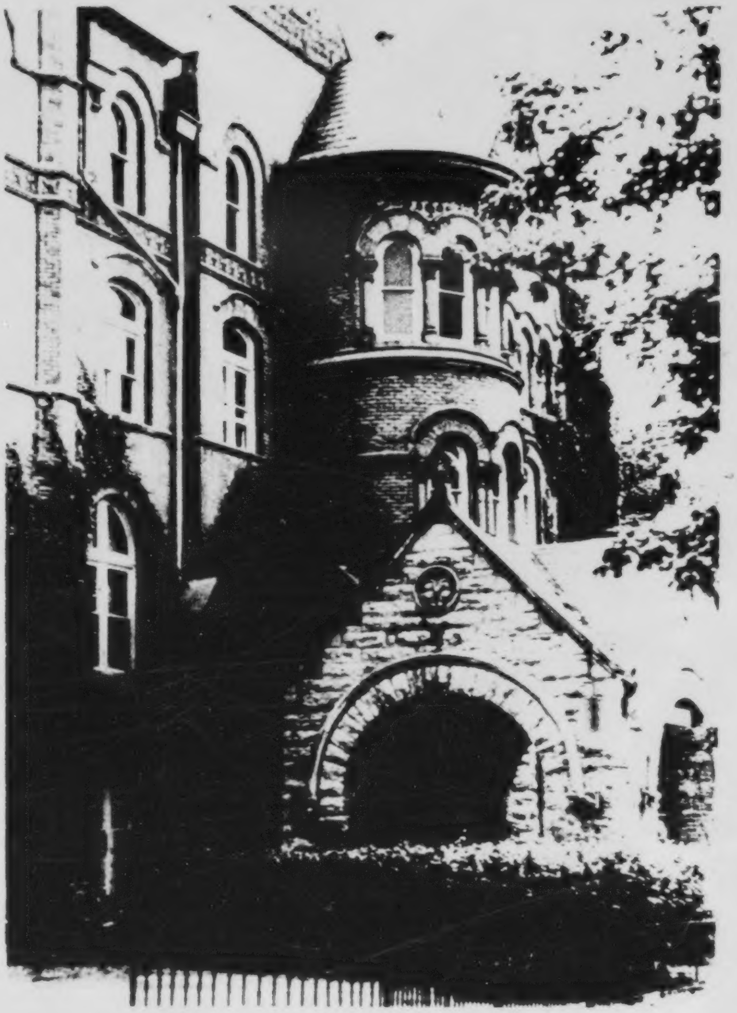

Photo reprinted from the Macalester College 1976-78 Catalog

Table 1 is a comprehensive listing of all institutions which participated in the post-secondary educational profile of the National Environmental/Energy Workforce Assessment. Listed by state, institution, and degree are programs surveyed in the areas of air, energy, noise, pesticides, potable water, radiation, solid waste and wastewater.

An explanation of the degree abbreviations utilized within the report may be found in Appendix I, entitled "Degree Abbreviations". For a complete listing of the institutions visited in a media specific area (i.e., air, energy, etc.), attention is drawn to Appendix IV, entitled "Participating Institutions by Environmental Category".

The Table in part III of the Project Findings, entitled "A Summary Profile of Representative Educational Programs" follows the narrative and is a presentation of specific institutions visited for the particular volume.

TABLE I

PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)*
AL	University of Alabama University	Environmental Engineering	M.S. (3)
AK	University of Alaska Fairbanks	Environmental Quality Engineering Science	M.S.
AR	University of Arkansas Fayetteville	Agricultural Engineering	B.S. M.S. Ph.D.
		Civil Engineering	M.S.C.E.
		Environmental Engineering	M.S.En.E.
		Environmental Science	B.S.
CA	California Institute of Technology Pasadena	Environmental Engineering Science	M.S. Ph.D.
	California Polytechnic State University San Luis Obispo	Environmental Engineering	B.S.
	California State University-Sacramento Sacramento	Civil and Environmental Engineering	B.S. M.S.
	Stanford University Stanford	Environmental and Water Studies	M.S. Ph.D.
	University of California-Berkeley Berkeley	Nuclear Engineering	B.S. M.S. M.E. Ph.D. D.E.
		Pest Management	B.S.
		Sanitary Engineering	M.S. M.E. Ph.D.
	University of California-Davis Davis	Environmental Toxicology	B.S.
		Plant Protection and Pest Management	M.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of California-Davis (Cont'd)	Entomology	B.S. M.S. Ph.D.
	University of California-Riverside Riverside	Pest Management	M.S.
	University of California-Santa Barbara Santa Barbara	Environmental Studies	B.A.
CO	Colorado State University Fort Collins	Environmental Engineering (Civil)	M.S. Ph.D.
	Community College of Denver-Red Rocks Golden	Water-Wastewater Technology	A.A.
CT	Hartford State Technical College Hartford	Nuclear Engineering Technology	A.S.
	Yale University New Haven	Environmental Health	M.P.H.
DE	Delaware Technical and Community College Newark	Environmental Engineering Technology	A.A.S.
	University of Delaware Newark	Entomology and Applied Ecology	B.S.
		Environmental Engineering	M.A.S. M.E. Ph.D.(App. Science) Ph.D.(ChE)
DC	Catholic University Washington	Civil Engineering	B.S.
	Howard University	Environmental Engineering	M.E.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
FL	Broward Community College Fort Lauderdale	Pest Control Technology	A.S.
	Central Florida Community College Ocala	Radiological Health Technology	A.S.
	Florida International University Miami	Environmental Studies	B.A. B.S.
		Environmental Engineering Technology	B.S.
	Heed University Hollywood	Ocean and Environmental Affairs	M.A. Ph.D.
	Miami-Dade Community College Miami	Environmental Engineering Technology	A.S.
		Marine Science Technology	A.S.
	University of Florida Gainesville	Air Pollution	M.E. M.S. Engineer Ph.D.
		Environmental Biology	M.E. M.S. Engineer Ph.D.
		Environmental Resources Management Activities	M.E. M.S. Engineer Ph.D.
		Systems Ecology	M.E. M.S. Engineer Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Florida (Cont'd)	Water Supply and Water Pollution Control	M.E. M.S. Engineer Ph.D.
		Nuclear Engineering	B.S.(N.E.) B.S.E.(N.E.) M.E. M.S. Engineer Ph.D.
		Radiological Sciences	M.E. M.S.
	University of Miami Miami	Marine and Atmospheric Science	M.S. Ph.D.
GA	Abraham Baldwin Agricultural College Tifton	Plant Protection	A.Ag.
	Atlanta University Center/ Georgia Institute of Technology Atlanta	Water Pollution Control Design Engineering	B.S. B.E.
	Georgia Institute of Technology Atlanta	Acoustical Engineering	Advanced Cert.
		Energy Engineering	Advanced Cert.
		Environmental Studies	Advanced Cert.
	Southern Technical Institute Marietta	Nuclear Safety	A.S.
	University of Georgia Athens	Entomology	B.S. A.B. M.S. M.P.P.P.M. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Georgia (Cont'd)	Environmental Health Science	B.S.E.H.
HI	University of Hawaii Honolulu	Environmental and Sanitary Engineering	M.S.
IL	Illinois Institute of Technology Chicago	Environmental Engineering	B.S.E.S. M.S. Ph.D.
	Prairie State Community College Chicago Heights	Air, Water, Wastewater	A.A.S.
	Sangamon State University Springfield	Environments and People	B.A. M.A.
	Southern Illinois University-Edwardsville Edwardsville	Wastewater Treatment Operator Training	Cert.
IN	Indiana University Bloomington	Environmental Programs	Cert. A.S. B.A. B.S. M.P.A. M.S.E.S. Ph.D. (minor)
	Purdue University West Lafayette	Environmental Sciences Option	B.S.
		Nuclear Engineering	B.S.N.E. M.S. Ph.D.
IA	Iowa State University Ames	Environmental Studies	B.A. B.S.
		Sanitary Engineering and Water Resources	M.S. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Kirkwood Community College Cedar Rapids	Environmental Health Assistant	Diploma
		Environmental Health Technician	A.A.
		Water and Wastewater	Diploma
	University of Iowa Iowa City	Environmental Engineering	M.S. Ph.D.
		Environmental Toxicology	M.S. Ph.D.
KS	Kansas State University Manhattan	Chemical Engineering	B.S. M.S. Ph.D.
		Mechanical Engineering	B.S. M.S. Ph.D.
		Nuclear Engineering	B.S. M.S. Ph.D.
		Sanitary Engineering	M.S.C.E.
	University of Kansas Lawrence	Environmental Health Engineering	M.S. Ph.D.
		Environmental Health Science	M.S. Ph.D.
		Environmental Studies	B.A.
		Radiation Biophysics	B.A. B.S. M.S. Ph.D.
		Water Resources Engineering and Science	M.S. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
KY	Morehead State University Morehead	Environmental Studies	B.S. A.B.
		Mining Technology	A.A.S.
	Pikeville College Pikeville	Mining Technology	A.M.T.
	University of Kentucky Lexington	Energy (Coal) Engineering	M.S. Ph.D.
		Environmental Engineering	M.S. Ph.D.
	University of Louisville Louisville	Environmental Engineering	B.S. M.Eng.
	Western Kentucky University Bowling Green	Environmental Science	B.S.
		Environmental Engineering	B.S.
LA	Delgado College New Orleans	Urban Pest Management	A.S.
		Water/Wastewater Technology	A.S.
		Environmental Health Technology	A.S.
	McNeese State University Lake Charles	Environmental Science	B.S. M.S.
ME	Eastern Maine Vocational Technical Institute Bangor	Environmental Control Technology	A.A.S.
	New England Regional Wastewater Institute (S. Maine Vocational Technical Institute) S. Portland	Wastewater Treatment Technology	Cert.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Maine-Orono Orono	Sanitary Engineering	M.S.C.E. Ph.D.
MD	Charles County Community College La Plata	Pollution Abatement Technology	A.A.
	Johns Hopkins University Baltimore	Environmental Engineering	M.A. M.S.E. M.S. Ph.D
	University of Maryland College Park	Environmental Engineering	M.S.
		Nuclear Engineering	M.S.
		Pest Management	M.S.
MA	Harvard University Cambridge	Environmental Health Sciences	S.M. Sc.D.
		Environmental Sciences and Engineering	S.M. M.E. Ph.D.
		Toxicology	S.M. Sc.D.
	Massachusetts Institute of Technology Cambridge	Acoustics	S.M. Sc.D./Ph.D.
		Environmental Engineering	Env.E.
		Mineral Resources Engineering and Management	S.M. Engr. Sc.D./Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Massachusetts Institute of Technology (Cont'd)	Nuclear Engineering	S.B. S.M. N.E. Sc.D./Ph.D.
		Water Resources and Environmental Engineering	S.B. S.M. Sc.D./Ph.D.
		Wastewater Treatment Plant Operations	Cert.
	Northeastern University Boston	Environmental Engineering and Science	M.S.
	Springfield Technical Community College Springfield	Environmental Technician	A.S.
	Tufts University Medford	Environmental Health Engineering	B.S.C.E. M.S.
	University of Lowell Lowell	Radiological Health Physics/Radiological Sciences and Protection	B.S. M.S.
		Wastewater Treatment Plant Operations	Cert.
MI	Ferris State College Big Rapids	Environmental Health Technician	A.A.S.
		Environmental Health	B.S.
	Michigan State University East Lansing	Environmental Conservation Education	M.S. Ph.D.
		Environmental Engineering	B.S.C.E. M.S. (emphasis) Ph.D. (emphasis)

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Michigan State University (Cont'd)	Natural Resources and Environmental Education	B.S.
		Systems Science (Ecological Systems)	B.S. M.S. Ph.D.
	Michigan Technological University Houghton	Environmental Engineering	B.S.C.E. B.S.E. M.S.C.E.
	University of Michigan Ann Arbor	Environmental Education	M.S.
		Environmental Sciences Engineering	B.S.
		Industrial Hygiene and Air Pollution	M.P.H. M.S. Dr.P.H. Ph.D.
		Radiological Health	M.P.H. M.S. Dr.P.H. Ph.D.
		Water Resources: Engineering	M.S.E. Ph.D.
		Management Science	M.S. Ph.D.
		Water Quality	M.P.H. M.S. Dr.P.H. Ph.D.
MN	Bemedji State College Bemedji	Environmental Studies	B.S. M.A.
	Macalester College St. Paul	Environmental Studies	B.A. B.S.
	University of Minnesota Minneapolis	Environmental Health	M.P.H. M.S. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
MS	Mississippi State University Mississippi State	Specialized Training in Pest Management	M.Ag.
MO	Missouri Southern State College Joplin	Environmental Health Technology	A.S. B.S.
		Radiologic Technology	A.S.
	St. Louis Community College at Forest Park St. Louis	Radiologic Technology	A.S.
	University of Missouri-Columbia Columbia	Sanitary Engineering	B.S. M.S. Ph.D.
	University of Missouri-Rolla Rolla	Environmental and Sanitary Engineering	M.S. Ph.D.
	Water and Wastewater Technical School Neosho	Water and Wastewater Training	Cert.
	Washington University St. Louis	Air (emphasis)	M.S. D.Sc.
MT	Montana State University Bozeman	Environmental Engineering	M.S.
		Environmental Health Technology	M.S.
	Northern Montana College Havre	Environmental Health Technology	A.A. Cert.
NE	Central Technical Community College Hastings	Agriculture Technology	Cert. 1-Year Diploma 2-Year Diploma A.A.S. A.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Nebraska Lincoln	Sanitary Engineering	B.S. M.S. Ph.D.
		Water Resources Engineering	M.S.
		Planning and Management	M.S.
NH	University of New Hampshire Durham	Entomology	B.S. B.A.
NJ	Middlesex County College Edison	Environmental Health Science Technology	A.A.S.
	New Jersey Institute of Technology Newark	Interdisciplinary Studies in Environmental Engineering	M.S.
	Princeton University Princeton	Energy Conversion and Resources	Topical Programs
	Rutgers-SUNJ New Brunswick	Biology (option in entomology)	B.S. B.A.
		Entomology and Economic Zoology	M.S. M.P. Ph.D.
		Environmental and Business Economics	B.S.
		Environmental Science	M.S. Ph.D.
		Environmental Studies	B.S.
		Environmental and Water Resources Engineering	M.S. Ph.D.
		International Environmental Studies	B.A. B.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Rutgers-SUNJ (Cont'd)	Radiation Sciences	M.S. Ph.D.
	Stevens Institute of Technology Hoboken	Air Pollution Control Engineering	Cert.
		Water and Wastewater Engineering	Cert.
NM	New Mexico State University Las Cruces	Pest Management	B.S.
	University of New Mexico Albuquerque	Nuclear Engineering	M.S. Ph.D.
NY	Clarkson College Potsdam	Civil and Environmental Engineering	B.S. M.S.
	Columbia University New York City	Nuclear Engineering	B.S. M.S. Nuc.Engr. Eng.Sc.D.
	Cornell University Ithaca	College Program in Energy Conversion	B.S.
		Environmental Engineering	B.S. M.S. M.Eng. Ph.D.
		Waste Management Engineering	M.S. M.Eng. M.P.S. Ph.D.
		Nuclear Engineering	M.Eng. M.S. Ph.D.
	Hofstra University Hempstead	Solid Waste Management	Cert.
	Hudson Valley Community College Troy	Public Health Technology (Environmental option)	A.A.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Hunter College New York City	Environmental Health Science	B.S. M.S.
	Manhattan College New York City	Environmental Engineering and Science	M.S. M.E.
	Polytechnic Institute of New York New York City	Energy Engineering and Policy	Cert. M.S.
		Environmental Engineering and Planning	M.S.C.E. M.E.H.S. Engr. Ph.D.
	Rensselaer Polytechnic Institute Troy	Environmental Engineering	B.S. M.E. M.S. D.E. Ph.D.
		Nuclear Engineering	B.S. M.S. M.E. Ph.D.
	Rochester Institute of Technology Rochester	Civil Engineering Technology (Environmental option)	B.T.
	State University of New York-Buffalo Buffalo	Water Resources and Environmental Engineering	B.S. M.S. Ph.D.
	State University of New York Farmingdale	Pest Control Technology	A.A.S.
	Syracuse University Syracuse	Chemical Engineering	B.S. M.S. Ph.D.
		Environmental Engineering	B.S.
		Sanitary Engineering, Sanitary Science, Civil Engineering	M.S.(S.E.) M.S.(S.S.) Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	The Cooper Union New York City	Integrated Master's Program with concentration in Environmental Engineering	M.E.
	Ulster County Community College Stone Ridge	Water Quality Management Training	A.A.S.
	University of Rochester Rochester	Toxicology Training Program	M.S. Ph.D.
NC	Duke University Durham	Environmental Management	M.E.M.
		Civil Engineering/ Urban and Environmental Engineering	M.S. Ph.D.
	North Carolina State University Raleigh	Agricultural Pest Control	A.A.S.
		Pest Management	B.S. M.S. (minor)
		Air Conservation	M.S. (minor) M.E. (minor) Ph.D.(minor)
		Environmental Engineering	M.S. M.C.E. Ph.D.
		Acoustic, Noise Vibration	M.S. M.M.E. Ph.D.
	University of North Carolina Chapel Hill	Air and Industrial Hygiene	M.S. M.S.P.H.
		Environmental Chemistry and Biology	M.S. M.S.P.H. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of North Carolina (Cont'd)	Environmental Management Protection	M.S. M.S.P.H. Ph.D.
		Radiological Hygiene	M.S. M.S.P.H. Ph.D.
		Water Resources Engineering	M.S. M.S.P.H. M.S.E.E. Ph.D.
	Wilson County Technical Institute Wilson	Sanitary Landfill Operating Manager	Cert. Diploma A.A.S.
		Sanitary Landfill Technology	A.A.S.
ND	North Dakota State School of Science Wahpeton	Environmental Science Technology	A.A.
OH	Antioch College Yellow Springs	Environmental Studies	B.S.
	Hocking Technical College Nelsonville	Environmental Health Technology	A.A.S.
	Miami University Oxford	Environmental Science	M.En.
	Muskingum Area Technical College Zanesville	Environmental Quality Control Technology	A.A.S.
		Natural Resources Conservation Technology	A.A.S.
		Petroleum Engineering Technology	1-Year Cert. A.A.S.
	Ohio State University Columbus	Agricultural Engineering	B.S. M.S. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Ohio State University (Cont'd)	Chemical Engineering (air)	B.S. M.S. Ph.D.
		Civil Engineering	B.S. M.S. Ph.D.
		Environmental Biology	M.S. Ph.D.
		Environmental Education	B.S.(Ed.) B.S.(N.R.) M.S. Ph.D.
		Toxicology (Pharmacology)	M.S. Ph.D.
	Ohio University Athens	Environmental Studies	M.S.
	Raymond Walters General and Technical College (University of Cincinnati) Cincinnati	Environmental Control/ Protection Technology	A.S.
	University of Cincinnati Cincinnati	Air Pollution and Industrial Hygiene	M.S. Ph.D.
		Civil and Environmental Engineering	M.S. Ph.D.
		Environmental Health	M.S. Ph.D.
		Mechanical and Industrial Engineering (noise)	B.S. M.S. Ph.D.
		Occupational Medicine	M.S. Ph.D.
		Toxicology	M.S. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Cincinnati (Cont'd)	Acoustics and Noise Control	B.S. M.S. Ph.D.
	University of Toledo Toledo	Chemical Engineering, Civil Engineering	B.S. M.S.
		Engineering Science	M.S.
OK	East Central Oklahoma State University Ada	Environmental Science	B.S.
	OSU Oklahoma City Technical Institute Oklahoma City	Civil Technology	A.S.
	Oklahoma State University Stillwater	Engineering Technology	A.D. B.S.
		Radiation and Nuclear Engineering Technology	A.D. B.S.
	Oscar Rose Junior College Midwest City	Wastewater Technology	A.A.S.
		Environmental Science	A.A.S.
	University of Oklahoma Norman	Environmental Science	B.S. M.S. Ph.D.
OR	Linn-Benton Community College Albany	Wastewater Technology	A.S.
		Water/Wastewater Technology	A.S.
		Water/Wastewater Plant Operator	Cert.
	Oregon Institute of Technology Klamath Falls	Environmental Technology	A.A.S. B.T.
	Oregon State University Corvallis	Nuclear Engineering Technology	B.S.
		Nuclear Engineering	B.S. M.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Oregon State University (Cont'd)	Pest Management and Plant Pathology	B.S. M.S.
	Portland State University Portland	Engineering and Applied Science	B.S. M.S.
PA	Carnegie-Mellon University Carnegie Institute of Technology Pittsburgh	Environmental Engineering	B.S. M.S. Ph.D.
	Drexel University Philadelphia	Environmental Engineering and Science	M.S.E.E. M.S.E.S. Ph.D.
	Pennsylvania State University University Park	Acoustics	M.E. M.S. Ph.D.
		Air Pollution Control Technology	A.A.P.C.T.
		Entomology	B.S. M.Agr. M.S. Ph.D.
		Environmental Engineering	B.S. M.S. M.E.E.E. Ph.D.
		Environmental Pollution Control	M.S. M.E.P.C. M.E.
		Environmental Resource Management	B.S.
		Minerals Processing	M.S. Ph.D.
		Mining Technology	A.A.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Pennsylvania State University (Cont'd)	Mining Engineering	B.S. M.S. M.E. Ph.D.
		Nuclear Engineering Technology	A.N.E.T.
		Nuclear Engineering	B.S. M.S. M.E. Ph.D.
		Petroleum and Natural Gas Engineering	B.S. M.S. Ph.D.
		Water Resources Engineering Technology	B.T.
	Slippery Rock State College Slippery Rock	Environmental Studies	B.S.
	Temple University Philadelphia	Environmental Technology	A.T.
		Environmental Engineering Technology	B.S.
	University of Pennsylvania Philadelphia	Energy Engineering	M.S.E.
		Energy Management and Policy	M.S.E.M.P. Ph.D.
	University of Pittsburgh Pittsburgh	Environmental and Sanitary Engineering	B.S. M.S. Ph.D.
		Environmental Systems Engineering	degrees granted through Engr. Dept.
	School of Public Health (University of Pittsburgh) Pittsburgh	Acoustic Environmental Control	M.S.(Hyg.) D.S.(Hyg.)
		Air Resources	M.S.(Hyg.)

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	School of Public Health (University of Pittsburgh) (Cont'd)	Environmental Health Engineering	M.P.H. D.S.(Hyg.)
		Environmental Health Planning	D.S.(Hyg.)
		Health Aspects of Water Quality	M.S.(Hyg.)
		Industrial Hygiene	M.S.(Hyg.)
		Toxicology	D.S.(Hyg.) Ph.D.
		Radiation Health	M.S.(Hyg.) D.S.(Hyg.) Ph.D. D.P.H.
RI	University of Rhode Island Kingston	Environmental Engineering	B.S. M.S. Ph.D.
SC	Clemson University Clemson	Air Pollution	M.S. M.Engr.
		Natural Systems	M.S. M.Engr.
		Planning and Management	M.S. M.Engr.
		Water Treatment Systems	M.S. M.Engr.
		Environmental Systems Engineering	Ph.D.
	Greenville Technical College Greenville	Wastewater Technology	A.A.S.
	Sumter Area Technical College Sumter	Environmental Engineering Technology	A.E.T.
TN	Chattanooga State Technical Community College Chattanooga	Environmental Science Technology	A.S.
		Nuclear Technology	A.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	East Tennessee State University Johnson City	Environmental Health	B.S.E.H. M.S.E.H.
	Memphis State University Memphis	Audiology	M.A. Ph.D.
	Middle Tennessee State University Murfreesboro	Environmental Science and Technology	B.S.
	State Technical Institute at Memphis Memphis	Environmental Engineering Technology	A.E.
	University of Tennessee Knoxville	Environmental Engineering	M.S.E.E. M.E. Ph.D.
		Environmental Engineering (Air Quality and Pollution Control)	M.S.E.E. M.E. Ph.D.
		Environmental Engineering (Water Pollution Control/ Water Resources)	M.S.E.E. M.E. Ph.D.
		Industrial Audiology	M.A.
		Nuclear Engineering	B.S. M.E. M.S. Ph.D.
		Water Resources Development	M.S.
	Vanderbilt University Nashville	Environmental and Water Resources Engineering (EWRE)	B.E.
		Environmental Science	B.S.
		EWRE (Environmental Science)	M.S. M.Eng. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Vanderbilt University (Cont'd)	EWRE (Air Resources)	M.S. M.Eng. Ph.D.
		EWRE (Solid Waste)	M.S. M.Eng. Ph.D.
		EWRE (Water and Wastewater Treatment/Water Resources)	M.S. M.Eng. Ph.D.
TX	Baylor University Waco	Institute of Environmental Studies	B.A. B.S.
	Lamar University Beaumont	Environmental Science	B.S.
		Energy Resource Management	B.S.
	Rice University Houston	Environmental Science and Engineering	M.S.
	Sam Houston State University Huntsville	Environmental Science	B.S.
	Texas A & M University College Station	Environmental Engineering	M.S. Ph.D.
		Entomology	M.S.
		Entomology/Pest Management Option	M. Ag.
	Texas State Technical Institution Waco	Nuclear Technology	A.A.S.
		Water/Wastewater Technology	A.A.S.
		Water Utility Operator	Certificate
	University of Texas Austin	Environmental Health Engineering	M.S. Ph.D.
		Water Resources Engineering	M.S. Ph.D.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
UT	Brigham Young University Provo	Chemical Engineering	B.S. M.S.
		Water Resources and Environmental Engineering	B.S. M.S.
	University of Utah Salt Lake City	Civil Engineering	B.S. M.E. M.S. Ph.D.
	Utah State University Logan	Civil and Environmental Engineering	B.S. M.S. Ph.D.
		Pest Management	B.S. M.S.
		Environmental Studies	B.S.
VA	George Washington University NASA-Langley Institute Hampton	Acoustics	M.S. Sc.D.
		Environmental Modeling	M.S.
	J.Sargeant Reynolds Community College Richmond	Environmental Technology Environmental Operations	Cert. A.A.S.
		Ground Water Resources	Cert.
	Virginia Polytechnic Institute and State University Blacksburg	Civil Engineering Technology	B.S.
		Sanitary Engineering/Environmental Sciences and Engineering/Civil Engineering	M.S. Ph.D.
	Wytheville Community College Wytheville	Environmental Technology	Cert.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
WA	The Evergreen State College Olympia	Coordinated Studies	B.A.
	University of Washington Seattle	Environmental Studies	B.A. B.S.
		Air Resources	M.S. Ph.D.
	Washington State University Pullman	Environmental Science	B.S. M.S.
		Chemical Engineering	M.S.
		Air Pollution Control Engineering	M.S.
		Air Pollution Science	M.S.
		Air Pollution Option	M.S.
		Air Pollution Program	M.S.
	Western Washington University Bellingham	Environmental Studies	B.S.
WV	Bluefield State College Bluefield	Mining Engineering Technology	A.S. B.S.
	West Virginia Institute of Technology Montgomery	Mining Engineering Technology	A.S.E.M.T. B.E.M.T.
	West Virginia University Morgantown	Engineering of Mines	B.S.
		Environmental Engineering	M.S.C.E. M.S.E.
		Mineral Processing Engineering	B.S. M.S.
		Mineral Resource Economics	M.S.
		Petroleum Engineering	B.S. M.S.

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STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
WI	Marquette University Milwaukee	Environmental Engineering	B.A. B.S.
	Northland College Ashland	Environmental Studies	B.A.
	University of Wisconsin-Green Bay Green Bay	Environmental Emphasis	B.A. B.S. M.E.A.S.
	University of Wisconsin-Madison Madison	Civil and Environmental Engineering	B.S.
		Environmental Communications	M.A. M.S.
		Water Resources Management, Environmental Monitoring, Land Resources	M.S. Ph.D.
	University of Wisconsin-Milwaukee	Atmospheric and Marine Environmental Program	M.S. M.E.
WY	Casper College Casper	Water Quality Technology	A.S.
	University of Wyoming Laramie	Civil Engineering	M.S. Ph.D.

Other Programs

The following programs were included in the on-site visit process and offer training through various institutes, centers, state agencies, or college consortiums. Program descriptions can be found in the volume specified.

State	Institution	Program	Volume
FL	Florida Department of Environmental Regulation	Environmental Noise Control Training	Noise
	Miami-Dade Community College	NPDES Effluent Monitoring Training	Wastewater I
		Wastewater Treatment Plant Operations	Wastewater I
		Water Treatment Plant Operations	Potable Water I
	University of Miami School of Medicine	Pesticide Protection	Pesticides
KS	Kansas State University	Institute for Environmental Research	Composite II III Business and Industry
MI	Michigan State University	Institute of Water Research	Potable Water I
		Pesticide Research Center	Pesticides
NE	University of Mid-America	Pests, Pesticides and Pesticide Safety	Pesticides

State	Institution	Program	Volume
NJ	Princeton University	Environmental Science and Policy	Composite I
NC	U.S. Environmental Protection Agency	Air Pollution Training Institute	Air
OH	Ohio State University	Center for Lake Erie Area Research	Potable Water I
		Cooperative Extension Service Activities	Composite II and III
		Water Resources Center	Potable Water I
PA	Air Pollution Control Association	Refresher, Continuing Education Courses	Air
	University of Pittsburgh	Environmental Systems Engineering	Composite I
TN	Memphis State University	Nuclear Reactor Fundamentals	Energy
		Radiation Technician Training Course	Radiation
	Oak Ridge Associated Universities	Radiation Emergency Assistance Center/ Training Site	Radiation
		Special Training	Energy Radiation
	University of Tennessee Center For Health Sciences	Training Courses in Audiometric Orientation	Noise

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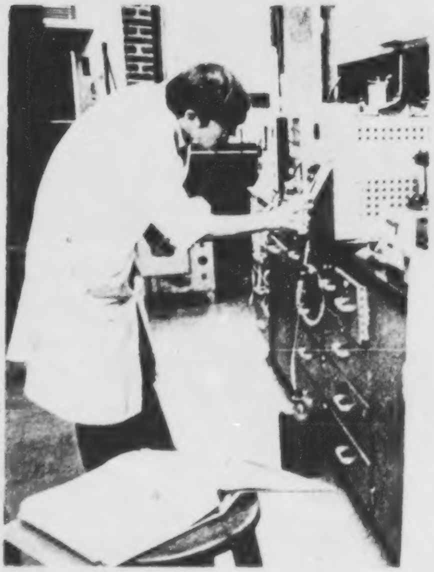
PROJECT FINDINGS



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C1

PROJECT FINDINGS

I. A SUMMARY PROFILE OF REPRESENTATIVE ENVIRONMENTAL ENGINEERING/ HEALTH EDUCATIONAL PROGRAMS

A. States, Institutions, Programs, and Degrees

The Post-Secondary Education Profile (Phase II) Composite: Engineering/ Health includes 93 programs. Originating in 32 states, these programs represent degree offerings from the diploma to the doctoral level. They were selected for inclusion in the survey on the basis of information and recommendations obtained during the workforce assessment phase of this three-year project, from institutional catalogs, and from a review of other published sources of information regarding degree programs in environmental areas. Project personnel gathered detailed information concerning these composite programs through on-site interviews and supplementary correspondence and telephone conversations.

Summary statistics discussed in sections below indicate that programs fall predominately in baccalaureate, masters, and doctoral degree levels and are heavily skewed to the eastern, mid-western, and southern regions. These results do not necessarily indicate that Environmental Engineering and Environmental Health programs do not exist at the sub-baccalaureate level or in western regions. Rather these results caution against making any strict definitive conclusions regionally or across degree levels. The preponderance of degree programs at the bachelors and graduate levels in not surprising given that Environmental Engineering and Environmental Health programs traditionally offer these degrees.

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B. Enrollment Statistics and Graduates

Data regarding numbers of full-time and part-time students and the average number of graduates from the Engineering/Health programs surveyed are reported nationally in Table 2.

Part-time enrollment is highest at the master's and doctoral levels which may reflect numbers of students who have completed coursework and are writing theses or dissertations.

Contact personnel report that one-third (33 percent) of the composite programs (or degree offerings, in some cases) surveyed are experiencing upward trends in numbers of graduates annually and an additional 53 percent report stable numbers of diplomas conferred over the last few years. These results suggest a constant to growing production rate of environmental workforce personnel in the Environmental Engineering and Health areas from post-secondary institutions.

Although the survey instrument contained a question concerning enrollment of women, available responses tended to be highly generalized making tabulation and statistical analyses of this item difficult. Comments recorded by interviewers indicate that the percentage of women enrolled in these programs is slowly increasing. This increment may be attributed in part to the excellent job market for females in the environmental area, as perceived by contact personnel.

C. Student Origin

Results regarding student origin (i.e., in-state, out-of-state, foreign) reported in Table 3 reveal some interesting though expected differences across degree levels.

TABLE 2

ENVIRONMENTAL ENGINEERING / HEALTH

NATIONAL ENROLLMENT PROFILE[1]

Degree	Enrollment Full-time	Enrollment Part-time	Graduates Average # Per Year	Enrollment Change by Program[2] Up	Down	Stable
Diploma	14	0	8	0	1	0
Associate	248	65	108	3	4	5
Bachelors	3282	126	858	20	3	14
Masters	1165	604	683	18	7	35
E.E.[3]	4	12	9	0	1	1
Doctoral	238	72	88	9	5	25
TOTAL	4951	879	1754	50	21	80

[1] This profile does not include all institutions offering similar programs in the country. Caution must therefore be taken in drawing any definitive conclusions regarding this profile.

[2] In some cases, figures represent individual degrees.

[3] Environmental Engineering.

TABLE 3

NATIONAL STUDENT-ORIGIN PROFILE

Degree	In-State	Out-of-State	Foreign
Diploma	100%	0%	0%
Associate	97%	3%	1%
Bachelors	85%	14%	2%
Masters	51%	38%	11%
E.E.	N/A	N/A	50%
Doctorate	48%	40%	11%

Students at the diploma, associate, and bachelors levels are predominately in-state (100, 97, and 85 percent respectively), while graduate enrollment is divided almost equally between in-state and out-of-state or foreign students. The reasons for these percentages are not absolute but may reflect several conditions. One, graduate programs--especially those offering excellent research facilities, in-state tuition rates, and assistantships or fellowships--can attract quality, out-of-state students who are competitive with any candidates maintaining residence in home states. Tuition remission and comparable financial aid offers are not widespread at the undergraduate level. Two, associate and baccalaureate degree students may be most attracted to or most familiar with institutions within a reasonable proximity to their homes, especially if full-time employment is a mitigating factor in program choice. Third, some institutions specify the ratio of in-state to out-of-state students.

D. Employment and Environmental Occupations

The job placement of graduates trained in Environmental Engineering, Health, and related areas plays a critical role in meeting environmental workforce needs. Though graduate follow-up characterizes approximately three out of every five programs (or degrees, in some cases), surveys of former students vary in specificity and completeness among institutions. Therefore, data concerning employment of graduates--particularly beyond initial placement--are less than exact. As part of this Phase II survey, contact personnel were asked what percentage of their program graduates are employed in industry, consulting, government, or other fields (teaching positions, etc.). Employment results by degree level are reported in Table 4.

Nationally, industry and government appear to draw greater numbers of Environmental Engineering and Environmental Health graduates than consulting firms and educational institutions. Though statistical analyses were not performed, variance across degree levels does not appear significant.

Government, as defined in this survey, encompasses the broad public sector (municipal, state, regional, and federal levels). In large measure, environmental regulation, monitoring, enforcement, and overall protection activities fall under the auspices of this sector. Past legislative mandates to the private sector have precipitated employment opportunities in the public sector to insure implementation. Likewise, the public sector has been forced to employ environmentally-trained personnel in order to comply with public sector legislation. Thus, both government and industry need personnel.

TABLE 4

ENVIRONMENTAL ENGINEERING / HEALTH

NATIONAL EMPLOYMENT PROFILE[1]

	Private Sector[2]				
Degree	Industry	Consulting	Total	Government	Other
Diploma	1%	0%	1%	99%	0%
Associate	32%	14%	46%	53%	0%
Bachelors	36%	17%	53%	38%	10%
Masters	29%	25%	54%	39%	7%
E.E.[3]	58%	11%	69%	27%	3%
Doctoral	28%	30%	58%	32%	10%
TOTAL	32%	20%	52%	39%	8%

[1] This profile does not include all institutions offering similar programs in the country. Caution must therefore be taken in drawing any definitive conclusions regarding this profile.

[2] If contact persons did not distinguish between industry and consulting in their responses, the private sector percentage given was evenly divided between industry and consulting.

[3] Environmental Engineering

The salaries that some educational institutions can afford to pay do not compare favorably with those in government or the private sector, nor are job openings as numerous. Both considerations may help explain the low percentage of graduates entering teaching positions.

The training represented by these environmental engineering, health, and related programs essentially prepares students for work in industry, government, and consulting, and not teaching, except at the doctoral level. That is to say, training and job placement correlate highly. Though the design of this project does not permit ascertainment of longitudinal shifts in employment, such a study would be potentially very useful in projecting necessary modification in training.

In an attempt to identify more specifically those occupations which Environmental Engineering/Health graduates would be qualified to fill, survey participants were asked to check on a prepared form those jobs that graduates of a given degree program would be trained to assume. Occupational titles so identified by a majority of contact personnel responding are listed below according to degree level:

Certificate

Air Pollution Control Technician
Air Pollution Control Technician (trainee)
Environmental Monitoring Specialist
Environmental Specialist/Solid Waste Management
Regulatory Specialist
Sanitary Technician
Solid Waste Collection Operator
Vector Control Specialist

Associate

Air Pollution Control Technician
Environmental Control Technologist
Environmental Engineering Technician
Environmental Health Aide/Technician
Environmental Monitor Specialist
Environmental Tester/Analyst
Pollution Control Specialist
Sanitary Technician
Wastewater Treatment Plant Operator
Water/Wastewater Equipment Technician
Water/Wastewater Treatment Operator

Bachelors

Environmental Engineer
Environmental Engineer - Water Pollution Control
Environmental Engineer - Water Resources
Industrial Waste Inspector
Public Health Sanitarian/Inspector/Engineer
Sanitarian
Water/Wastewater Treatment Operator
Wastewater Treatment Plant Operator

Masters

Environmental Engineer
Environmental Engineer - Water Pollution Control
Environmental Engineer - Water Resources
Environmental Specialist/Solid Waste Management
Pollution Control Specialist
Sanitary Engineer

Environmental Engineering

Air Pollution Analyst
Air Pollution Control Engineer
Environmental Control Technologist
Environmental Engineer
Environmental Engineer - Water Pollution Control
Environmental Engineer - Water Resources

Doctoral

Environmental Engineer
Environmental Engineer - Water Pollution Control

E. Graduate Follow-Up

As indicated earlier, approximately 60 percent of the Environmental Engineering, Health, and related technology programs surveyed engage in some form of graduate follow-up with varying degrees of success. Common methods used are newsletters, questionnaires, personal contact, conventions and professional gatherings, and alumni association records. No responses to this survey item appear unique to a single institution. The important task of tracing graduates, not only to maintain job histories but to obtain curriculum feedback, demands that both program administrators and program graduates share the responsibility.

F. Faculty

Of the 93 Environmental Engineering, Health, and related programs surveyed in Phase II, full-time faculty total 823 and part-time faculty total 383. These figures are based essentially on intra-program definitions of full- or part-time staff assignments. For example, some programs define part-time personnel as faculty who may teach only one course and whose primary responsibilities rest in another department. This factor alone makes any generalization difficult. There do not appear to be any consistent differences across degree levels.

G. Internship/Applied Study Term

Of the 157 separate degree programs offering information, 46 provide for some form of internship or applied study term as part of their student training. These options offer students supervised, on-the-job experience related to their classroom and laboratory instruction. Internship or applied study terms prepare students for real-world situations encountered in subsequent employment and may facilitate job placement. For some students, salaries paid to them for their work under these application oriented instructional programs are a means of financial aid. Environmentally related internship programs place students in industry, consulting, government, and business.

II. ADDITIONAL FINDINGS

A. Recruitment Techniques

While some programs claim that their reputation alone attracts quality applicants, most utilize some formal means of recruitment. Posters, brochures, visitations to local high schools, and campus career days number among the most popular. Graduate programs often attract students from the same institution's undergraduate student body; and university offices (admission, public relations) supervise and supplement program recruitment efforts on many campuses. Those programs with extensive research facilities, traineeships, or other curricular or financial attractions find such inducements facilitate recruitment. Former graduates often steer potential students to programs. One institution even televises the "success stories" of its graduates. The success of any one recruitment method is difficult to project across programs and is in reality undoubtedly the function of many intervening variables.

B. Sources of Student Support

Student financial aid packages also help in the recruitment process. For those programs included in this Environmental Engineering/Health volume, undergraduates typically are supported by scholarships; federal, state, and campus loan programs; college work study; and part-time employment outside the university. The majority of graduate students enrolled in many of these programs are employed by their departments as teaching or research assistants or as support personnel on program grants or contracts. At the graduate level, support funding and/or tuition remission or reduction are often critical variables in enrollment. Traineeships from federal agencies such as the Environmental Protection Agency and the National Institute of Occupational Safety and Health to support students are considered too few in number.

C. Research Funding

The financial stability of environmental programs is often a key to their success or demise. Monies for research enable programs to attract faculty and students. Research funding--most typically in the form of grants, contracts, or consulting work--accounts for minimal to substantial percentages of faculty salaries. Those institutions with more support personnel and services (e.g., graduate students, clerical help, grant writing officers, or research centers) and those able to offer faculty release time for research, not surprisingly tend to be those schools where research funds are more abundant.

Sources of research funding vary widely across programs. More frequently cited ones include:

1) Department of Energy
2) Department of Interior
3) Department of Health, Education, and Welfare
4) Housing and Urban Development Administration
5) National Aeronautics and Space Administration
6) National Geological Survey
7) National Institute of Health
8) National Institute of Occupational Safety and Health
9) National Science Foundation
10) Occupational Safety and Health Administration
11) Office of Water Research Technology
12) Rockefeller Foundation
13) Sea Grant
14) U.S. Air Force, Army, and Navy
15) U.S. Environmental Protection Agency
16) U.S. Public Health Service

State agencies, private corporations, regional study commissions, and other entities also provide important research funding.

More important perhaps than the question of what agency is giving that most in environmental research funds and student stipends to the educational community is the issue of how critical the continuation and escalation of such financial support is for the maintenance and growth of existing programs. Curriculum changes, additional faculty lines, laboratory costs, and salary increments cost money. Environmental programs are looking more and more to the federal government for financial support. A substantial number indicate that without that support, their programs are in danger of decline and even collapse. (For more detailed information regarding sources of research funding and research activities, see individual program summaries.)

D. Usage of ERIC and IRIS

Computerized information retrieval systems now available to the educational community greatly speed initial reviews of literature and provide inexpensive access to a wide variety of materials. ERIC and IRIS are two such retrieval systems that include environmentally related materials. The inherent effectiveness of ERIC and IRIS depends in part of their utilization with the educational community. Of the 51 Environmental Engineering/Health programs responding to a survey question on usage of these systems, only seven contact persons (13 percent) indicated that they use ERIC and only six persons (12 percent) indicate that they use IRIS. Engineering Health program responses and responses from all institutions participating in this Phase II survey concerning use of ERIC and IRIS are reported in Tables 5 and 6. The results of the composite section parallel those at the national level.

TABLE 5

ERIC/IRIS UTILIZATION PROFILE - ENGINEERING/HEALTH

	Yes	No	Total Responding
ERIC	7	43	51
IRIS	6	44	51

TABLE 6

ERIC/IRIS UTILIZATION PROFILE - NATIONAL SUMMARY

	Yes	No	Total Responding
ERIC	72	307	379
IRIS	64	314	378

Faculty members responding to this ERIC/IRIS survey item were not asked the reasons for their answers, but a sizable percentage indicated that they were not even aware of these particular information retrieval systems. The fact that IRIS primarily contains water and wastewater materials may help explain the unfamiliarity of environmental engineering and health faculty with this system if their expertise and teaching responsibilities are not in these two areas. However, these results must prompt questions of how widely disseminated and how widely publicized ERIC and IRIS services are within the environmental training community. Other retrieval systems mentioned by faculty members include CRIS (Cooperative Research Information Service), NTIS (National Technical Information Service), Oak Ridge Nuclear Information Center, TOXLINE, and a Water Research Institute system as well as individual library computer systems for information retrieval.

E. Program Flexibility

Changing employment needs and new technology necessitate curriculum modifications in the educational training of our environmental workforce. The time constraints under which schools can implement new courses or new programs (e.g., series of courses, degree offerings) give some indication of the flexibility of the Environmental Engineering, Health, and related programs surveyed in Phase II. Tables 7 and 8 summarize the responses to questions asking the time needed to implement new courses and new programs.

The number of responses in the one-month to one-year category indicates that course and program changes can usually be implemented within an academic calendar year. Differences across degree levels do not appear significant. Program modifications appear to take more time than course implementation which is not surprising given the greater scope of a program relative to a single course. Responses to these questions were often conditional; participants indicated that implementation schedules depend in large measure on the availability of faculty time and financial resources, departmental and institutional support, and the preparation readiness of course syllabi and materials. The responses noted in these tables may indeed only represent the minimum time needed to process course and program requests through the institutional structure if there are no intervening complications.

F. Communication and Financial Management Skills

A concern of professionals in the environmental workforce is that graduates often are weak in the communication skills needed to inform the

TABLE 7

TIME REQUIRED TO IMPLEMENT A COMPLETE CONTENT CHANGE IN A COURSE

Degree Program	Less than 1 month	1 month-1 year	more than 1 year; less than 2	2-4 years	more than 4 years	Undetermined
Associate	3	7	0	0		3
Bachelors	5	26	1	1		6
Masters	7	40	1	0		9
Doctoral	4	30	1	0		6
TOTAL	19	103	3	1		24

TABLE 8

TIME REQUIRED TO IMPLEMENT A COMPLETE PROGRAM SEQUENCE

Degree Program	Less than 1 month	1 month-1 year	more than 1 year; less than 2	2-4 years	more than 4 years	Undetermined
Associate	0	5	2	3		3
Bachelors	0	16	2	9		12
Masters	3	29	3	8		14
Doctoral	1	21	1	6		11
TOTAL	4	71	8	26		40

public and private sectors regarding pollution and its control and abatement and the persuasive expertise to stimulate constructive social action based on that information. Survey participants were asked their reactions to this concern. Those contact persons representing Environmental Engineering, Health, and related technologies generally agree that adequate communication skills of environmentally trained persons are of major concern. The curricular response designed to sharpen students capabilities in this important area varies from one institution to another and across degree levels. Many undergraduate engineering programs require that students take a technical writing course, while graduate students in all areas typically must write an acceptable thesis or dissertation and are encouraged to publish their work. Students at all levels are usually called upon to present oral reports in classes and seminars. A common consensus among environmental educators is that post-secondary students in all disciplines--not just Environmental Engineering and Health--lack adequate communication-skills preparation. The solution of this problem rests with the entire educational community and is not easily achieved.

Similar concerns regarding financial management skills of environmental graduates elicited slightly different responses. Some survey participants maintain that associate- and bachelors-level graduates do not necessarily need an in-depth knowledge of economics because they typically take sub-managerial jobs which do not require financial decision-making. Engineering course work at some point usually emphasizes the cost benefits and economic considerations of proposed designs. Nevertheless, educators agree that environmental policy and decision-making must reflect sound short- and long-term economic projections.

III

A Summary Profile of Representative Educational Programs

The following footnotes (1-6) refer to the various column headings of the Table. Other footnotes are specific to the figures which were provided by various institutions and are used throughout the Table.

[1] Enrollment - 1976-77 statistics

[2] Graduates - average for last three years; 'change' indicated apparent trends within that three-year period

[3] Employment - 'other' includes positions such as those found within the educational community

[4] Faculty - full-time and part-time is determined by individual institutions

[5] Internship/Applied Study - part of an option to obtain a degree; may or may not have financial reimbursement connected with it

[6] Graduate Follow-up - a standardized procedure that enables the institution to periodically determine the employment of their graduates

[7] enrollment figures are estimated

[8] Juniors and Seniors only

[9] students specializing in environmental areas

[10] no longer functional

NA - Not Available/Not Applicable

*Asterisk - denotes that a program appears in more than one volume of the profile

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

				ENROLLMENT[1]		GRADUATES[2]	
STATE	INSTITUTION	PROGRAM	DEGREE	FULL TIME	PART TIME	No. / YEAR	CHANGE
AL	University of Alabama	Environmental Engineering	M.S. (3)	16	0	4	Up
AK	University of Alaska	Environmental Quality Engineering	M.S.	3	9	3	Down
AR	University of Arkansas	Agricultural Engineering	B.S.	57	0	5	Up
			M.S.	3	0	2	Stable
			Ph.D.	2	0	0	Up
		Environmental Science/Engineering/Civil Engineering	B.S.	25	0	15	Stable
			M.S. (En.E.)	5	30	8	Stable
			M.S. (C.E.)	1	0	N/A	Down
CA	California Polytechnic State University	Environmental Engineering	B.S.	161	0	25	Stable
	California Institute of Technology	Environmental Engineering Science	M.S.	7	0	8	Stable
			Ph.D.	20	0	5	Stable
CT	Yale University	* Environmental Health	M.P.H.	20	0	10	Stable

9

ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR INDUSTRY	PRIVATE SECTOR CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
85/15/0	15%	60%	20%	5%	8	3		X	X	
83/17/0	50%		50%		2	0		X		X
94/0/6	40%	10%	50%		11	0		X		X
33/0/67	40%	10%	50%					X		X
50/0/50		N/A						X		X
95/5/0	33%	33%	33%		5	0		X	X	
90/10/0	33%	33%	33%					X	X	
90/10/0	33%	33%	33%				X		X	
99/1/0	70%		30%		6	0	X		X	
20/80/0	30%	50%	20%		18	0		X	X	
20/80/0	15%	50%	10%	25%				X	X	
25/50/25	50%		50%		10	0	X		X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

				ENROLLMENT[1]		GRADUATES[2]	
STATE	INSTITUTION	PROGRAM	DEGREE	FULL TIME	PART TIME	No. / YEAR	CHANGE
DE	Delaware Technical and Community College	+Environmental Engineering Technology	A.A.S.	20	20	10	Stable
	University of Delaware	Environmental Engineering	M.A.S. M.E.	14	14	6	Stable
			Ph.D.	1	0	1	
DC	Catholic University	Civil Engineering	B.S.	72	0	15-20	Up
	Howard University	Environmental Engineering	M.E.	20	4	10	Up
FL	Florida International University	Environmental Engineering Technology	B.S.	13[7]	52[7]	12	Stable
	Heed University	Ocean and Environment Affairs	M.A.	0	0	0	Stable
			Ph.D.	0	3	2	Stable
GA	Georgia Institute of Technology	Environmental Studies	Adv. Cert.	N/A	N/A	5	Varies
	University of Georgia	Environmental Health Science	B.S.E.H.	75	0	26	Up
IN	Purdue University	*Environmental Sciences Options	B.S.	15	0	4	Stable

9

ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/ APPLIED STUDY[5]		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
99/1/0	99%		1%		2	2		X		X
33/33/33 33/33/33	30%	40%	30%		4	0		X	X	
50/50/0	30%		30%	40%	7	2	X			X
10/45/45		45%	45%	10%	4	1		X		X
80/20/NA	30%		70%		5	5		X		X
10/90/0	N/A	N/A	N/A	N/A	17	0		X	N/A	
N/A	N/A	N/A	N/A	N/A	0	13		X		X
88/12/NA	50%		30%	20%	1	0		X	X	
67/33/0	25%		50%	25%	280	0		X		X

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES[2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
IA	Kirkwood Community College	Environmental Health Assistant	Dipl.	14	0	8	Down
		Environmental Health Technician	A.A.	5	0	5	Down
KS	Kansas State University	Chemical Engineering	B.S.	180	0	35	N/A
			M.S.	12	0	4	Stable
			Ph.D.	10	0	2	Stable
		Mechanical Engineering	B.S.	276	0	50	Stable
			M.S.	13	4	10	Stable
			Ph.D.	7	4	2	Stable
	University of Kansas	Environmental Health Engineering/ Science	M.S.	15	15	10	Stable
			Ph.D.	7	3	1-2	Stable
KY	University of Louisville	Environmental Engineering	B.S.[8]	26	0	13	Up
			M.E.	14	0	6	Up
	Western Kentucky University	Environmental Engineering Technology	B.S.	40	0	8	Up
		Environmental Science	B.S.	37	0	7	Up

9

ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
100/0/0	1%		99%		1	1	X		X	
100/0/0	1%		99%		1	1	X		X	
N/A	70%		10%	20%	11	0		X	X	
N/A	70%		10%	20%				X	X	
N/A	60%	10%	10%	20%				X	X	
N/A		N/A			16	1	X			X
N/A		N/A					X			X
N/A		N/A					X			X
20/74/6	5%	55%	40%		4	1		X	X	
20/74/6	5%	55%	40%					X	X	
92/8/NA	40%		55%	5%	9	0	X		X	
78/22/NA	17%	21%	43%	19%	2	7		X	X	
80/20/NA	17%	21%	37%	25%	2	7		X	X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES[2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
LA	Delgado College	Environmental Health	A.S.	41	0	6	Stable
	McNeese State University	Environmental Science	B.S.	23	4	10	Stable
			M.S.	24	0	7	Stable
ME	University of Maine	*Sanitary Engineering	M.S.	14	0	5	Up
			Ph.D.	3	0	1	Up
MD	John Hopkins University	Environmental Engineering	M.S. M.S.E. M.S. (Systems) Ph.D.	43	7	6-8	Up
MA	Massachusetts Institute of Technology	Environmental Engineering	Env.Eng.	3	0	2	Stable
	Springfield Technical Community College	*Environmental Technology	A.A.S.	26	0	10	Up
MI	Ferris State College	Environmental Health Technician	A.A.S.	29	0	17	Down
			B.S.	82	0	29	Up

9

ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR INDUSTRY	PRIVATE SECTOR CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
95/5/NA	50%		50%		3	10		X		X
95/5/NA	95%		5%		5	2		X	X	
80/15/5	60%		40%					X	X	
N/A	25%	50%	25%		5	0		X	X	
N/A	25%	50%	25%					X	X	
12/88/0		10%	40%	50%	11	1	X			X
12/88/0		10%	40%	50%			X			X
12/88/0		10%	40%	50%			X			X
12/88/0		10%	40%	50%			X			X
N/A		50%	35%	15%	N/A	N/A	X			X
90/10/0	20%		80%		2	0	X		X	
99/1/0	40%	0	60%	0	6	2		X		X
99/1/0	40%	0	60%	0				X		X

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

				ENROLLMENT[1]		GRADUATES[2]	
STATE	INSTITUTION	PROGRAM	DEGREE	FULL TIME	PART TIME	No. / YEAR	CHANGE
MI	Michigan State University	Environmental Engineering	B.S.[9]	55	5	30	Stable
			M.S.	6	4	8	Stable
			Ph.D.	1	1	.25	Stable
	University of Michigan	Environmental Science Engineering	B.S.E.	79	0	10-12	N/A
		*Industrial Hygiene	M.S.	11	0	9	Up
			M.P.H.	24	0	8	Stable
			D.P.H.	0	0	0	Stable
			Ph.D.	10	0	2	Stable
MN	University of Minnesota	Environmental Health	M.P.H. M.S. Ph.D.	50	30	40	Stable
NJ	Middlesex	*Environmental Health Science Technology	A.A.S.	15	4	15	Stable
	New Jersey Institute of Technology	Interdisciplinary Studies in Environmental Engineering	M.S.	N/A	N/A	N/A	N/A
	Rutgers-State University of New Jersey	*Environmental Science	M.S. Ph.D.	70	60	40	Up
	Stevens Institute of Technology	Environmental Engineering/ Environmental Science	M.S.	0	0	N/A	N/A

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ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
90/9/1	2%	80%	18%		3	0	X		X	
90/9/1	2%	80%	18%					X	X	
90/9/1	2%	80%	18%					X	X	
N/A	30%	20%	50%		0	0		X	X	
64/36/0	90%		10%		3	0	X		X	
54/42/4	90%		10%				X		X	
N/A		N/A					X		X	
50/40/10	90%		10%				X		X	
40/55/5	15%	5%	75%	5%	8	10		X		X
100/0/0	83%		17%		4	0	X		X	
96/4/0		N/A			10	0	X			X
75/25/0	35%		50%	15%	12	2	X			X
	35%		50%	15%				X		X
N/A		N/A			6	2		X		X

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1] FULL TIME	ENROLLMENT[1] PART TIME	GRADUATES [2] No. / YEAR	GRADUATES [2] CHANGE
NJ	Stevens Institute of Technology	Environmental Engineering/ Environmental Science	M.E.	1	0	N/A	N/A
			Ph.D.	0	0	N/A	N/A
NY	Clarkson College	Civil and Environmental Engineering	B.S.	530	0	120	Up
			M.S.	20	5	12	Up
	Cornell University	*Environmental Engineering	B.S.	15	0	15	Down
			M.S.	18	0	15	Down
			M.Eng.				
			Ph.D.				
		Waste Management Engineering	M.S.	8	0	6	Stable
			M.Eng.				Stable
			M.P.S.				Stable
			Ph.D.				Stable
	Hunter College	Environmental Health Science	B.S.	34	0	10	Up
			M.S.	20	32	12	Stable
	Polytechnic Institute of New York	Environmental Engineering and Planning	M.E.H.S.	2	15	5	Stable
			M.S.C.E.				
			Engr.	12	115	72	Down
			Ph.D.				

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ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT PRIVATE SECTOR INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FACULTY[4] FULL TIME	PART TIME	INTERNSHIP/[5] APPLIED STUDY YES	NO	GRADUATE[6] FOLLOW-UP YES	NO
0/0/100		N/A			6	2		X		X
N/A		N/A						X		X
90/10/0	60%		40%		21	1		X	X	
90/10/0	60%		40%					X	X	
N/A	80%		20%		5	0	X			X
N/A								X		X
N/A	15%	75%	10%					X		X
N/A								X		X
N/A	25%	50%	25%		4	6		X		X
N/A	25%	50%	25%					X		X
N/A	25%	50%	25%					X		X
N/A		25%	25%	50%				X		X
N/A	20%		30%	50%	3	4	X		X	
N/A	3%	13%	38%	46%			X		X	
NA/NA/50	75%		25%		12	0		X		X
NA/NA/50	75%		25%					X		X
NA/NA/50	75%		25%					X		X
NA/NA/50	75%		25%					X		X

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1] FULL TIME	PART TIME	GRADUATES[2] No. / YEAR	CHANGE
NY	Rensselaer Polytechnic Institute	*Environmental Engineering	B.S.	20	0	25	
			M.E.	40	14	20	N/A
			M.S.				
			Eng.D.			3	
			Ph.D.				
	Syracuse University	Environmental Engineering	B.S.	44	0	12	Stable
	The Cooper Union	Integrated Master's Program in Engineering	M.E.	25	0	N/A	N/A
NC	Duke University	Civil Engineering/ Urban and Environmental Engineering	M.S.	26	0	8	Stable
			Ph.D.		0	4	Stable
	North Carolina State University	Environmental Engineering	M.C.E.	22[6]	0	8[7]	Down
			M.S.		0		
			Ph.D.		0	3	
	University of North Carolina	Environmental Management and Protection	M.S.	21[7]	N/A	0	
			M.S.P.H.			10	Stable
			M.P.H.			.5	
			Ph.D.	1	N/A	0	Stable

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ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
20/80/0	20%	60%	20%		4.5	5.5	X		X	
20/80/0	20%	60%	20%					X	X	
60/40/0	25%	50%	25%		0	12		X		X
85/15/0	75%		25%		0	20	X			X
10/90/NA		66% 66%	33%	33%	11	4		X		X
60/40/NA	7%	38%	38%	17%	0	8		X	X	
48/52/0		23%	46%	31%	3	1		X	X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES[2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
OH	Hocking Technical College	Environmental Health Technology	A.A.S.	53	1	15	Up
	Muskingum Area Technical College	*Environmental Quality Control Technology	A.A.S.	26	4	8	Up
	Ohio State University	Agricultural Engineering	B.S.	80	0	18-20	Stable
			M.S.	8	0	3	Stable
			Ph.D.	14	0	4	Stable
		*Civil Engineering	B.S.[9]	35	3	32	Up
			M.S.[9]	16	5	6-8	Up
			M.S./ P.A.	0	2	1	Stable
			Ph.D.[9]	4	1	1	Up
		Environmental Biology	M.S.	6	1	5	Stable
			Ph.D.	6	1	2	Stable
	Ohio University	Environmental Studies	M.S.	8	2	5-10	Stable
	Raymond Walters General & Technical College (University of Cincinnati)	Environmental Control/ Protection Technology	A.S.	17	8	12-15	Stable
	University of Cincinnati	Civil and Environmental Engineering	M.S.	20	50	20-25	Stable
			Ph.D.	2	5	1-2	Stable

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ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT PRIVATE SECTOR INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FACULTY[4] FULL TIME	PART TIME	INTERNSHIP/[5] APPLIED STUDY YES	NO	GRADUATE[6] FOLLOW-UP YES	NO
100/0/0	1%		99%		2	1	X		X	
99/1/0	50%	20%	20%	10%	2	0	X		X	
95/5/0	N/A	N/A	N/A	N/A	12	0		X	X	
80/20/0								X	X	
80/20/0								X	X	
80/17/3	20%	25%	40%	15%	7	0		X	X	
75/0/25	20%	30%	40%	10%				X	X	
100/0/0		40%	60%				X		X	
34/0/66	20%	20%	20%	40%				X	X	
80/20/0		80%	20%		0	18-20		X	X	
80/20/0		80%	20%					X	X	
60/40/0			50%	50%				X	X	
100/0/0	16%	16%	66%		4	3	X		X	
30/45/25	16%	16%	48%	20%	7	2	X		X	
30/45/25	16%	16%	48%	20%			X		X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

				ENROLLMENT[1]		GRADUATES[2]	
STATE	INSTITUTION	PROGRAM	DEGREE	FULL TIME	PART TIME	No. / YEAR	CHANGE
OH	University of Cincinnati	Environmental Health	M.S.	3	0	4	Down
			Ph.D.	13	0	1	Up
		*Industrial Hygiene	M.S.	23	22	12	Up
			Ph.D.	8	0	2	Up
		Occupational Medicine	M.S.	11	1	5	Stable
			Ph.D.	0	0	0	Stable
	University of Toledo	Environmental Engineering/ Engineering Science	B.S.Ch.E.	1	0	N/A	Stable
			B.S.C.E.	18	0	N/A	Stable
			M.S.Ch.E.	2	3	2	Stable
			M.S.C.E.	1	7	2	Stable
			M.S.Eng.S.	2	11	2	Up
OK	East Central Oklahoma State University	Environmental Science	B.S.	57	7	18	Up
	Oscar Rose Junior College	Environmental Science	A.A.S.	8	8	3	Stable
	OSU Oklahoma City Technical Institute	Environmental Health	A.S.	0	20	3	Down
	University of Oklahoma	Environmental Science	B.S.	40	0	10	Stable
			M.S.	42	93	30	Up
			Ph.D.	9	26	5	Up

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ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT PRIVATE SECTOR INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FACULTY[4] FULL TIME	PART TIME	INTERNSHIP/[5] APPLIED STUDY YES	NO	GRADUATE[6] FOLLOW-UP YES	NO
33/33/33	22%		57%	21%	11	0		X	X	
54/46/0	22%		31%	46%				X	X	
35/65/0	60%		40%		10	0		X	X	
20/30/50	20%		80%					X	X	
17/58/25	38%	5%	37%	20%	4	20	X		X	
N/A		N/A					X		X	
90/10/0	50%			50%	6	0	Variable		X	
70/20/10	30%	20%	40%	10%						
75/22/3	70%	20%	10%							
85/10/5	45%	15%	35%	5%						
70/10/20	50%	5%	45%							
70/30/NA	30%		70%		3	0		X	X	
92/NA/7	65%		35%		3	6	X		X	
100/NA/NA	60%		40%		2	1		X	X	
90/NA/10	10%	15%	75%		9	0		X	X	
68/7/25	30%	30%	40%					X	X	
70/10/20	30%	35%	25%	10%				X	X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES [2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
PA	Carnegie Institute of Technology	* Environmental Engineering	B.S.	N/A	N/A	34	Up
			M.S. M.E.	20	0	19	Up
			Ph.D.	8	0	2	Stable
	Drexel University	* Environmental Engineering and Science	M.S. M.E. Ph.D.	69	36	15 12 4	Up N/A Stable
	Slippery Rock State College	Environmental Studies	B.S.	45	0	9	Up
	Temple University	* Environmental Technology/ Environmental Engineering Technology	A.T.	8	0	2	Down
			B.S.	64	12	15	Up
	The Pennsylvania State University	* Environmental Engineering	B.S.	127	3	23	Up
			M.S. M.E. Ph.D.	19	0	8	Up
		* Environmental Pollution Control	M.S. M.E.P.C. M.E.	25	1	14	Stable
	University of Pittsburgh	* Environmental/ Sanitary Engineering	B.S.	35	0	12	Up

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ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR				FULL TIME	PART TIME	YES	NO	YES	NO
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]						
60/20/20	30%	50%	20%		8	0		X	X	
60/20/20	30%	50%	20%					X	X	
60/28/12	70%	6%	6%	18%	6	0	X		X	
60/28/12	70%	6%	6%	18%			X		X	
40/60/NA		55%	45%		7	10		X	X	
40/60/NA	10%	10%	80%					X	X	
NA/NA/NA		N/A	N/A	N/A	N/A	N/A		N/A	N/A	
59/38/3		8%	87%	5%	8	0		X	X	
37/58/5										
97/3/0	N/A	N/A	N/A	N/A	1	9		X		X
60/35/5	21%	17%	41%	21%	7	0		X	X	
30/70/NA	25%		75%		8	0		X		X

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1] FULL TIME	ENROLLMENT[1] PART TIME	GRADUATES[2] No. / YEAR	GRADUATES[2] CHANGE
PA	University of Pittsburgh	*Environmental and Sanitary Engineering	M.S.	30	30	35	Up
			Ph.D.	20	0	4	Stable
		*Industrial Hygiene and Air Engineering	M.S. M.P.H.	15	10	15	Up
SC	Clemson University	Environmental Systems Engineering	Ph.D.	10	N/A	3	Stable
		Natural Systems	M.S. M.Engr.	6	N/A	5	Stable
TN	Chattanooga State Technical Community College	Environmental[10] Technology	A.S.		N/A	N/A	N/A
	East Tennessee State University	Environmental Health	B.S.E.H.	146	0	47	Down
			M.S.E.H.	40	0	14	Down
	Middle Tennessee State University	Environmental Science and Technology	B.S.	31	31	12	Up
	University of Tennessee	Environmental Engineering	M.S.E.E. M.E.	32	21	16	Stable
			Ph.D.	4	0	3	Stable
	Vanderbilt University	Environmental Science	B.S.	9	0	4	Down

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ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT PRIVATE SECTOR INDUSTRY	EMPLOYMENT PRIVATE SECTOR CONSULTING	EMPLOYMENT GOV'T	EMPLOYMENT OTHER[3]	FACULTY[4] FULL TIME	FACULTY[4] PART TIME	INTERNSHIP/[5] APPLIED STUDY YES	INTERNSHIP/[5] APPLIED STUDY NO	GRADUATE[6] FOLLOW-UP YES	GRADUATE[6] FOLLOW-UP NO
50/50/0	40%	30%	30%		6	7		X	X	
25/62/18	40%	30%	30%					X	X	
25/62/18	40%	30%	30%					X	X	
50/50/0	60%		40%		0	37		X	X	
N/A	60%		40%					X	X	
50/50/0	60%		40%					X	X	
80/20/0	5%	90%	5%		0	14		X	X	
80/20/0	40%	40%	20%		2	0	X		X	
80/20/0	40%	40%	20%				X		X	
90/10/0	25%	45%	30%		10	0	X			X
50/50/0	25%	45%	30%		6	0		X		X
50/50/0	25%	45%	30%					X		X
50/50/0	25%	45%	30%					X		X
50/50/0	50%		30%	20%	0	40		X	X	
50/50/0	50%		30%	20%				X	X	
50/50/0	50%		30%	20%				X	X	
95/5/0	30%	50%	20%		8	0		X	X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES [2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
TN	Vanderbilt University	Environmental and Water Resources Engineering	B.E.	34	0	6	Up
		Environmental Science	M.S.	16	0	6	Stable
			M.Eng.	6	0	2	Up
			Ph.D.	10	0	2	Down
TX	Lamar University	Environmental Science	B.S.	125	0	15	Up
	Sam Houston State University	Environmental Science	B.S.	35	0	12	Stable
	Texas A & M University	Environmental Engineering	M.S.	14	0	3	Down
			Ph.D.	1	0	2	
UT	University of Utah	Environmental Engineering	B.S.	15	0	10	Stable
			M.S.	10	0	5	Stable
			Ph.D.	0	2	0	Stable
VA	Virginia Polytechnic* Institute and State University	Sanitary Engineering/ Environmental Sciences and Engineering/Civil Engineering	M.S.(San)	15	3	15	Stable
			M.S.(Env)	15	2	15	
			M.S.(Civ)	5	0	3	
			Ph.D.(CE)	4	0	2	

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ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT PRIVATE SECTOR INDUSTRY	EMPLOYMENT PRIVATE SECTOR CONSULTING	EMPLOYMENT GOV'T	EMPLOYMENT OTHER[3]	FACULTY[4] FULL TIME	FACULTY[4] PART TIME	INTERNSHIP/ APPLIED STUDY[5] YES	INTERNSHIP/ APPLIED STUDY[5] NO	GRADUATE FOLLOW-UP[6] YES	GRADUATE FOLLOW-UP[6] NO
30/70/NA	25%		75%		8			X		X
10/90/NA	25%		75%		8			X		X
98/2/NA	90%		10%		10		X		X	
98/2/NA	60%		40%		3			X	X	
50/50/NA	80%		20%		9	6		X	X	
50/25/25	65%		35%		5	2		X		X
50/50/NA	65%		35%							
50/50/NA	60%		30%	10%						
60/40/0	25%	25%	40%	10%	7	6		X		X

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES[2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
VA	Virginia Polytechnic Institute and State University	*Sanitary Engineering/ Environmental Sciences and Engineering/Civil Engineering	Ph.D. (Env.Sci.)	4	0	2	Stable
WV	West Virginia University	*Environmental Engineering	M.S. M.S.E.	20	0	10	Stable
WI	University of Wisconsin at Madison	Civil and Environmental Engineering	B.S.	526	N/A	100	Up
		Water Resources Management	M.S.	72		20	N/A
		Environmental Monitoring	M.S.	7		N/A	
			Ph.D	7		N/A	
		Land Resources	M.S.	21		N/A	
			Ph.D.	14		N/A	

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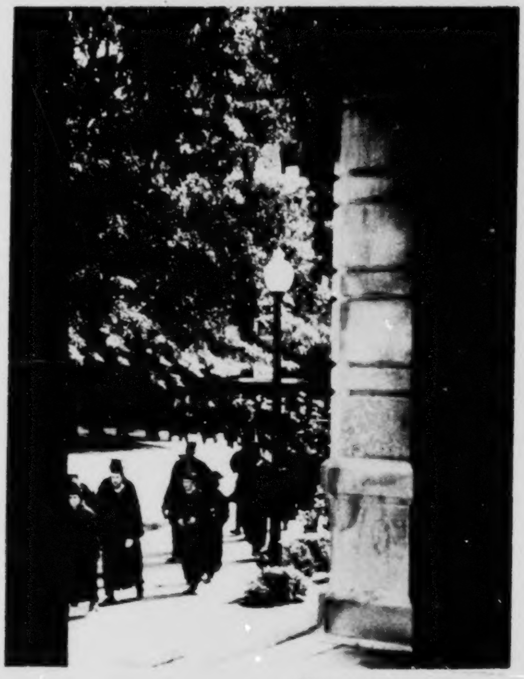
ENGINEERING/HEALTH PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
60/40/0	25%	25%	40%	10%	7	6		X		X
N/A	15%	10%	75%		5	3		X		X
85/10/5	35%		30%	35%	28	2	X			X
70/25/5	50%		50%			52	X		X	

Photo reprinted from the
Michigan Technological
University Catalog 1975-76

PROJECT COMMENTARY



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PROJECT CONSTRAINTS

In preparation for the on-site interviews, all of the institutions' catalogs were intensively reviewed in order to determine where environmental programs were being offered. During the course of this study, 171 institutions were visited and a total of 338 environmental programs, representing 45 states and Washington, D.C., were surveyed in detail. Albeit significant, these programs represent only a portion of all such programs available and cannot be construed as an in-depth survey of all environmental programs. It is, however, a representative sample within each of the environmental pollution control areas of Air, Noise, Pesticides, Radiation, Water and Wastewater, Solid Waste and Energy.

Several constraining factors to the proposed comprehensiveness of the study were encountered while collecting data from the institutions. It was disappointing to find that definitive records or statistics were generally unavailable which would describe specifically the placement of environmental program graduates. General indications of placement within categories, such as government or industry, were often available in percentages only. Depending on the size of the program and its age, some contact people could describe all graduates, others knew only where the past year's graduates were presently employed, and still others were aware only of their advisees entry-level positions and subsequent moves.

It also became clear during the on-site interviews that some programs of similar or identical content had different titles. This lack of clarity within the environmental areas serves to confuse the casual reader. For that reason, attention must be directed to the actual environmental course listings included in each program summary.

A list of terms commonly used during the on-site interviews and subsequently in this report was developed in order to facilitate precise data gathering. The reader is directed to Appendix II, TERMINOLOGY.

No attempt was made, in this report, to qualitatively judge any of these programs. The apparent absence of substantial qualitative measures in the environmental education field in general and the desire to collect data in a neutral atmosphere underscore the reasons for this omission. It appears that there is a need for the development of an environmental program model in each of these areas in order that some qualitative standards be provided where none now exist.

PROJECT COMMENTARY

The preceding analyses of data gathered from Environmental Engineering/Health programs indicate those trends and future projections that can be made given quantitative information from project participants. To synthesize and summarize, enrollments and workforce production in these composite programs are generally stable or increasing. Employment profiles indicate larger percentages of graduates enter industry and government service than consulting or teaching. Shifts in job placement cannot be determined from available data. Program personnel, for the most part, were able to categorize entry-level positions. Subsequent occupational transfers were not identifiable unless extensive graduate follow-up procedures were utilized. Several generalizations regarding employment trends may be ascertained by examination of the individual program summaries.

Future curriculum modifications reflect, among other things, job market demands, geographical location, legislative mandates, and growing environmental concerns. Courses recently developed in response to Environmental/Energy issues are indicative of the educational community's capacity to utilize regional resources in training and conceivably its ability to generate workforce personnel. Sanitary engineering programs, which are historically water- and wastewater-oriented, are expanding to include courses in air, solid waste, and even radiation. Comments from a number of survey participants indicate planned curricular expansion encompassing industrial hygiene, toxicology, radiation, and environmental health areas; many programs are planning course work in the energy area. Such curriculum modifications may well result in shifting numbers of graduates trained in any given environmental area. Detection of substantive changes in workforce capacity will require careful monitoring of enrollment and graduate statistics.

Environmental engineering/health educators are divided in their views regarding the breadth and specialization needed in training programs. Some maintain that graduates from bachelors and advanced degree programs are better prepared having received traditional engineering degrees and that specialization comes with employment experience. Others, particularly those at the sub-baccalaureate level, contend that training programs must recognize and prepare students for immediate workforce needs--that training must be highly application-oriented and practical. Another sentiment expressed by some is that programs must more effectively integrate training in a number of environmental areas (e.g., air, solid waste, wastewater) within single programs in order that graduates of these programs can deal capably with the complex, inter-relational demands of environmental pollution and its control and abatement. Varying views are undoubtedly the result of varying faculty backgrounds and degrees of past success in placing graduates. Personnel in the educational community want to prepare students for jobs that do exist, yet are hard-pressed to identify what those jobs are. Communication between post-secondary environmental programs and the private sector and government agencies that employ graduates of those programs is critical if environmental workforce needs are to be adequately met.

The future of Environmental Engineering/Health training programs, according to contact persons surveyed in this Phase II study, is generally positive. However, any level of optimism is highly and positively correlated with continued financial support and stable enrollments. Most program personnel regard these factors as highly unstable and dependent upon complex economic, political, and social developments.

LIST OF COMPOSITE TRAINING INSTITUTIONS BY DEGREE

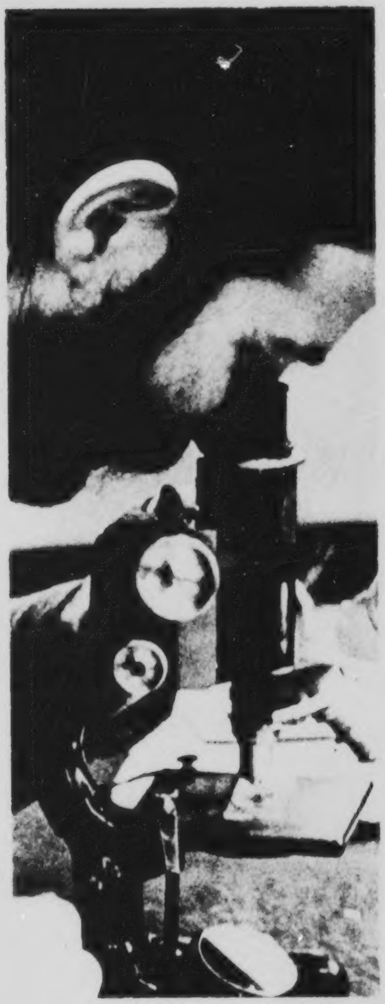


Photo reprinted from the
Northland College Catalog
1975-76

LIST OF COMPOSITE ENGINEERING/HEALTH TRAINING INSTITUTIONS BY DEGREE

CERTIFICATE

Georgia Institute of Technology (graduate level)

ASSOCIATE

Chattanooga State Technical Community College
*Delaware Technical and Community College
Delgado College
Hocking Technical College
*Middlesex County College
*Muskingum Area Technical College
OSU Oklahoma City Technical Institute
Oscar Rose Junior College
Raymond Walters General and Technical College
*Springfield Technical Community College

BACHELORS

California Polytechnic State University
Catholic University
East Central Oklahoma State University
Florida International University
Lamar University
Middle Tennessee State University
*Purdue University
Sam Houston State University
Slippery Rock State College
Syracuse University
University of Georgia
Western Kentucky University

MASTERS

Howard University
New Jersey Institute of Technology
The Cooper Union
University of Alabama
University of Alaska
*West Virginia University
*Yale University

ENVIRONMENTAL ENGINEER

Massachusetts Institute of Technology

MULTIPLE DEGREES OFFERED BY ONE INSTITUTION

Diploma/Associate

- Kirkwood Community College

Associate/Bachelors

- Ferris State College
- *Temple University

Bachelors/Masters

- Clarkson College
- East Tennessee State University
- Hunter College
- McNeese State University
- Ohio University
- University of Louisville
- University of Toledo

Bachelors/Masters/Doctoral

- *Carnegie Institute of Technology
- *Cornell University
- Kansas State University
- Michigan State University
- *Ohio State University
- *Rensselaer Polytechnic Institute
- *The Pennsylvania State University
- University of Arkansas
- *University of Michigan
- University of Oklahoma
- *University of Pittsburgh
- University of Utah
- University of Wisconsin at Madison
- Vanderbilt University

Masters/Doctoral

- California Institute of Technology
- Clemson University
- *Drexel University
- Duke University
- Heed University
- Johns Hopkins University
- North Carolina State University
- Polytechnic Institute of New York
- *Rutgers State University of New Jersey
- Stevens Institute of Technology
- Texas A & M University
- *University of Cincinnati
- University of Delaware

MUTLIPLE DEGREES OFFERED BY ONE INSTITUTION

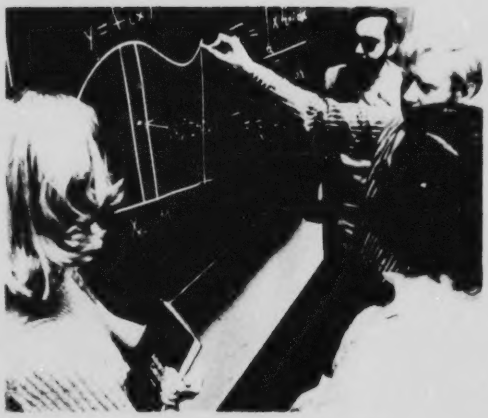
Masters/Doctoral (continued)

University of Kansas
*University of Maine
University of Minnesota
University of North Carolina
University of Tennessee
*Virginia Polytechnic Institute & State University

NON-DEGREE

Kansas State University - Institute for Environmental Research
Ohio State University - Cooperative Extension Service Activities
Princeton University - Energy Conversion and Resource

* Denotes that the program appears in another volume(s).



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COMPOSITE TRAINING SUMMARIES

Photo reprinted from the 1976-77 Annual Report, Engineering Experiment Station, College of Engineering, University of Wisconsin, Madison

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INSTITUTION: CALIFORNIA INSTITUTE OF TECHNOLOGY

PROGRAM: Environmental Engineering Science

DEPARTMENT: Interdisciplinary

DEGREE: Master of Science (M.S.), Doctor of Philosophy (Ph.D.)
Environmental Engineering Science

CONTACT: Dr. Jack E. McKee
Professor, Environmental Engineering
W.M. Keck Laboratory, Room 105
California Institute of Technology
Pasadena, California 91125
(213) 795-6811

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental studies have been available at Cal Tech for many years. Over 20 years ago, Professor Haggen-Smit demonstrated that the primary smog producers were automobiles and power plants, and not backyard incinerators as many people had believed. In 1960, the environmental health engineering program was established. Many of the faculty currently active in the program, were recruited at that time.

In 1969, in response to national concerns, and faculty and student interest, a new interdisciplinary program was established. With the inception of the new program, advanced degrees in environmental engineering science were offered.

The scope of the program includes the current issues of protection and control of man's environment. Faculty members from the Division of Engineering and Applied Science, Chemistry and Chemical Engineering, Humanities and Social Sciences, and Geological and Planetary Sciences cooperate in this interdisciplinary program. The program is strongly research oriented and each student is expected to plan for both breadth of environmental studies and depth of research in a particular subject.

Within the program are nine major areas of specialization. A student may choose: air quality control; environmental engineering; environmental economics and policy studies; environmental geochemistry; hydraulics and water resources; marine ecology; water chemistry; water supply and pollution control; or, wastewater reclamation and reutilization. Excellent laboratory facilities are available at the university. Studies in diffusion, turbulence, sediment transport and stratified flow are conducted at the Keck Laboratory of Hydraulics and Water Resources. Keck Laboratory is equipped with air quality instruments for measurements of gaseous and particulate atmospheric pollutants, which may be interfaced with a computer system for on-line data analyses. The Water Quality Laboratory is equipped for trace element analyses as well as microbiological measurements. The Kerckhoff Laboratory, located at Corona del Mar, is the research base for work in marine ecology.

Closely associated with the environmental engineering science program is the Enviornmental Quality Laboratory (EQL). The EQL is an independent research unit devoted to the study of policy questions in environmental protection and control. EQL research projects are often closely related to individual research efforts in the academic divisions. EQL research projects provide the framework for a comprehensive view of environmental control problems and alternative solutions.

PROGRAM REQUIREMENTS

The curriculum has been developed primarily for students pursuing the Ph.D. degree. The purpose of the Ph.D. program is to prepare students for careers in specialized research, advanced engineering, and planning and management of various environmental projects. The M.S. degree is offered for students choosing environmental engineering careers in engineering design, planning or management.

Minimum requirements for the Master of Science include successful completion of 135 quarter units of advanced courses. There are 108 quarter units of restricted electives and the remaining 27 units are for free electives of any graduate courses at the Institute. There is no thesis requirement for the master's degree.

Before a student can be recommended for admission to candidacy for the Ph.D. degree in environmental engineering science, the student must complete a series of advanced courses as arranged in consultation with the advisory committee. The student must also successfully complete at least 27 quarter units of course work in advanced mathematics or a satisfactory substitute. Finally, the student must pass a candidacy examination on the major subject. In order to broaden the student's program, at least 45 quarter units must be completed in a minor. The subject minor requires the approval of the environmental engineering faculty. A thesis and a final oral examination must be completed before the degree may be conferred.

CURRENT FACULTY, STUDENTS, GRADUATES

The faculty of Cal Tech is composed of some of the most outstanding scholars in the world today. The environmental engineering program is a beneficiary of this academic excellence. Some current topics being studied are water quality and wastewater treatment, air pollution and its effects on the human respiratory tract, and air pollution control strategies. The number of faculty directly involved in the program consists of nine that are teaching environmental engineering courses, and nine supporting faculty from other disciplines. Faculty are involved in both teaching and research. However, a small number are supported directly through research grants and must devote all of their time to such activities.

Currently, there are 27 graduate students in the program. This number varies little from year to year. The number of students in the master program is seven. Because the master's is usually completed in one year, about seven master's degrees are conferred annually. The Ph.D. program is somewhat larger. Currently, approximately 20 students are involved. The average number of students receiving their degree is four to five per year. Environmental Engineering is one of the larger programs in engineering at Cal Tech. Only physics and chemistry have more declared majors than environmental engineering.

Cal Tech graduates have no problem in securing employment in their field. At present, there are more requests than there are graduates. About 25% of the Ph.D. students elect university teaching. The majority of both Ph.D. and M.S. graduates become employed with consulting firms (50%). Less than 20% of Cal Tech graduates are employed by the public sector.

Historically, the number of women and foreign students have been small at the Institute. Only 5% of environmental engineering students are women and between 5% to 10% are foreign. Almost 80% of the students are from out of state.

Financial assistance is limited. Well qualified students, however, may receive teaching and research assistantships, industrial fellowships or tuition scholarships. all awarded by the Institute.

PROGRAM PROJECTIONS

Significant changes in faculty, student size or curriculum are not anticipated for the next few years. Environmental engineering at Cal Tech is looked upon as exemplary, and is one of the outstanding programs in the nation today. The Institute hopes to continue this reputation of excellence.

COURSE DESCRIPTION

Env 100 Special Topics in Environmental Engineering - Special courses, problems or research for graduate students working for the M.S. degree or qualified undergraduates. (6+ q.h.)

Env/GE 103 abc Oceans and Atmospheres - Natural physical and chemical processes in the earth's fluid envelope. (9 q.h.)

Env 112 abc Hydrologic Transport Process - The hydrologic cycle and its relation to man; statistical analysis and simulation of hydrologic data. (9 q.h.)

Env 116 Experimental Methods in Air Pollution - Methods of sampling and measurement of particulate and gaseous pollutants with applications to pollution sources, gas cleaning equipment, and smog formation. (9 q.h.)

Env 142 ab Chemistry of Natural Water Systems - Chemistry of electrolyte solutions, heterogeneous processes, and redox reactions applied to quantitative description of natural waters. (9 q.h.)

Env 143 Water Chemistry Laboratory - Laboratory experiments and measurements dealing with the major and minor constituents of natural waters. (9 q.h.)

Env 144 Ecology - Basic principles of ecology and ways in which human activities can influence natural populations. (6 q.h.)

Env 145 ab Environmental Biology - An exposition of basic biological principles concerning interrelations between organisms, particularly those directly affecting man and his environment. (10 q.h.)

Env 146 abc Analysis and Design of Water and Wastewater Systems - The application of science and engineering sciences to water supply and treatment for municipal use. (9 q.h.)

Env 150 abc Seminar in Environmental Engineering Science - Seminar on current developments and research within the field of environmental engineering science, with special consideration to work at the Institute. (1 q.h.)

Env 155 Special Problems in Waste Management - Environmental pollution related to nuclear energy; solid wastes from municipalities, industries, and agriculture; transportation and storage of hazardous materials, and detailed case studies of specific problems. (9 q.h.)

Env 156 Industrial Wastes - The production and characteristics of liquid industrial wastes; their effects upon municipal sewage treatment plants, receiving streams, and groundwaters. (9 q.h.)

ChE/Env 157 ab Fundamentals of Air Pollution Engineering - Basic concepts necessary to understand the sources, control and atmospheric behavior of air pollutants. Air quality and emission standards; sources, quantities, and nature of emissions. (9 q.h.)

Env 170 ab Aerosol Science - Physics and chemistry of small particle behavior with applications to gas cleaning, air pollution, and air chemistry. (9 q.h.)

Env 200 Advanced Topics in Environmental Engineering Science - Special topics in the application of engineering principles to biological and medical problems.

Env 206 Special Problems in Biological Engineering Science - Special topics in the application of engineering principles to biological and medical problems.

Env 250 Advanced Environmental Seminar - A seminar course for advanced graduate students and staff to discuss current research and technical literature on environmental problems. (4 q.h.)

INSTITUTION: CALIFORNIA POLYTECHNIC STATE UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Environmental Engineering

DEGREE: Bachelor of Science (B.S.) in Environmental Engineering

CONTACT:

Dr. Harold M. Cota
Environmental Engineering
California Polytechnic State University
San Luis Obispo, California 93407
(805) 546-2589

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental engineering program was developed in 1968 at California Polytechnic State University. At the time of inception, the program emphasis was on air pollution control and air-conditioning-refrigeration. In 1972, a new area was added to the program: water pollution-waste management.

The program offers the student a sound base in the fundamentals of engineering, and an area of concentration in one of the previously mentioned options. Approximately 60% of the students choose the air pollution and water pollution-waste management areas of specialization.

Graduates of this program find employment with private consulting firms, manufacturers, contractors and with governmental agencies. Examples of occupations which are selected by graduates include: air pollution control engineer; air pollution control inspector; audiologist; environmental engineer (noise); chemical engineer; water quality engineer; and, water pollution control engineer.

PROGRAM REQUIREMENTS

Qualified students of any high school may be admitted to California Polytechnic State University. Admission, however, is limited to those students for whom the university has adequate staff and facilities.

The Bachelor of Science degree requires completion of from 186 to 210 quarter hours or units. A minimum of 63 quarter hours are required from general education courses.

During the first year of the environmental engineering program, the student, in addition to the regular university courses and electives

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completes the introductory environmental engineer course. During the second year, this student will complete two environmental courses: environmental engineering measurements, and heating and ventilation. During the third and fourth years, students complete the following environmental courses, in addition to the regular curriculum: noise and vibration control; heat transfer; environmental air qualtiy; advanced mass and energy transfer; automatic process control; advanced system design; and, senior project and undergraduate seminar.

In addition to the course work, students are encouraged to work for federal, state and local agencies during the summer, between the junior and senior years.

CURRENT FACULTY, STUDENTS GRADUATES

At present the faculty for the environmental engineering programs totals six full-time teaching and administrative personnel. All six members are cost-centered.

Enrollment currently totals 161 full-time students. Of this total, 131 are male and 30 are female. Usually, this program does not attract the adult career change student. Normally, the program graduates approximately 25 students annually. Approximately 2% of these graduates elect to pursue their educational endeavors. The remaining 98% find employment in the private sector predominantly (70%). Approximately 30% of the graduates, however, enter employment with federal, state and local agencies.

PROGRAM PROJECTIONS

Significant changes in the faculty and in the student enrollment are not anticipated over the next few years. The program, according to the faculty, has stabilized. Substantive changes in the program structure are also not expected in the near future.

COURSE DESCRIPTION

EnvE 101 Introduction to Environmental Engineering - Nature and scope of the field of environmental engineering. (1 q.h.)

EnvE 251 Environmental Engineering Measurements - Experimental studies of the instrumentation and basic measurements of concern to the environmental engineer. (2 q.h.)

EnvE 309 Noise and Vibration Control - Behavior of sound waves, selection of instrumentation, practical measurements, criteria for noise and vibration control in environmental systems. (3 q.h.)

EnvE 321 Solar Energy - Methods of utilizing solar energy. Energy concepts. Collection and storage systems; greenhouse effect. (3 q.h.)

EnvE 324 Introduction to Air Pollution - Causes and effects of air pollution on the individual, the community and industry. (3 q.h.)

EnvE 325 Environmental Air Quality - Consideration of ambient air contamination inside and outside of a control space. (3 q.h.)

EnvE 326 Air Pollution Measurements - Planning and conduct of atmospheric surveys. Collection, evaluation, and interpretation of data as they pertain to the concentration of pollutants sampled. (3 q.h.)

EnvE 327 Water Pollution - Sources of pollution. Water quality standards. Principle techniques and operation. (3 q.h.)

EnvE 330 Environmental Quality Control - Aspects of the total environment. Application of scientific and engineering principles to control the development and use of air, water and land resources. (3 q.h.)

EnvE 411 Air Pollution Control - Theory, principles and practices related to the control of particulate emissions. Mechanical separations. (3 q.h.)

EnvE 421 Advanced Air Pollution Control - Theory, principles and practices related to the control of gaseous emissions. (3 q.h.)

EnvE 422 Environmental Radiation Surveillance - Sources of radioactive contaminants, biological effects, radiation protection. (2 q.h.)

EnvE 423 Industrial Environments - Effects of the environment in relation to health and the performance of work. (2 q.h.)

EnvE 434 Water Quality Measurements - Methods employed in the qualitative and quantitative determinations of water and waste water constituents. (2 q.h.)

EnvE 435 Water and Wastewater Treatment - Unit operations and unit processes encountered in potable water and wastewater treatment. (3 q.h.)

EnvE 438 Water and Wastewater Treatment - Application of the physical operation, and chemical and biological unit processes principles to the analysis and design of potable water and wastewater treatment facilities. (3 q.h.)

EnvE 439 Solid Waste Management - Chemical and physical properties of municipal and industrial refuse. Landfill disposal, incineration, composting. Industrial and commercial solid waste disposal. (2 q.h.)

INSTITUTION: CARNEGIE-MELLON UNIVERSITY
CARNEGIE INSTITUTE OF TECHNOLOGY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.), Master of Science (M.S.), Master of Engineering (M.E.), Doctor of Philosophy (Ph.D.)

CONTACT:
Dr. Francis Clay McMichael
Head, Department of Civil Engineering
Carnegie-Mellon University
Carnegie Institute of Technology
5000 Forbes Avenue
Pittsburgh, Pennsylvania 15213
(412) 621-2600

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering is not emphasized as a formal program at the Carnegie Institute of Technology. Emphasis is placed on research on environmental topics which is mainly conducted by departments of the College of Engineering. The principal areas of research are air pollution, industrial wastewater, solid waste management and energy. The prinicpal degree granting departments in the College conducting environmental research are the Chemical, Civil, Mechanical and Engineering and Public Policy Departments. The Engineering and Public Policy Department is also part of the Graduate School of Urban and Public Affairs. All of these departments are involved in undergraduate projects and graduate thesis research in the field of environmental engineering.

Selected institutes or research programs of the Carnegie Institute of Technology which are involved in environmental engineering are the Environmental Studies Institute (to be renamed the Center for Energy and Environmental Studies) which grants an M.E. in Environmental Studies, and the Division of Nuclear Science and Engineering.

The Department of Civil Engineering offers a graduate study option in Environmental Engineering. Emphasis is on water and wastewater treatment and management, and students receive a sound understanding of water science and water process technology. The Department cooperates with other departments and colleges within Carnegie-Mellon University to sponsor interdisciplinary programs leading to special degrees or joint degrees.

Research facilities for use of students in the program include an Environmental Engineering Laboratory for research mainly in the areas of water and wastewater chemistry. A unit operation laboratory is also utilized for both teaching and research. A clean laboratory is presently under construction for aerosol studies. Analytical facilities are available to measure common inorganic and organic indices of water quality.

PROGRAM REQUIREMENTS

The Department of Civil Engineering offers a variety of degrees at the Master's level. They include: M.S. in Civil Engineering; M.S. in Civil Engineering/Engineering and Public Policy; and Master of Engineering. The Master of Science degree requires a minimum of 96 academic units consisting of:

(1) at least 36 units of graduate courses in Civil Engineering;
(2) a minimum of 24 (a maximum of 42) units of graduate project,
(3) other approved courses as suggested by the faculty advisor, and;
(4) satisfactory completion of either a comprehensive final examination or an M.S. thesis.

The Department's Master of Engineering degree normally requires a minimum of 192 units of work with strong emphasis on interdisciplinary project work. Students register in an engineering department but select problems drawn from areas such as the environment. Ph.D. cnadidates complete an additional two years of graduate study beyond the M.S. degree. A qualifying examination and final examination are required, but no foreign language is required. There is a one-year residence requirement for the Ph.D.

Research assistantships, teaching assistantships and fellowships are offered to graduate students as financial aid. A much greater number of assistantships is available in comparison with the number of fellowships. Graduate assistantships are usually one-third time appointments requiring 12 hours of work for the Department weekly.

CURRENT FACULTY, STUDENTS, GRADUATES

The College of Engineering faculty, totaling about 90, teach both undergraduate and graduate students. The faculty devote about 67 percent of their time to teaching and 33 percent to research activities. The Civil Engineering faculty is composed of thirteen members, of whom six are full professors. Three professors have research interests in environmental engineering areas.

During 1977, the College of Engineering had research expenditures totalling about $6 million; of that amount, $3 million was for energy research, and one-third of the energy expenditures ($1 million) was for environmental-energy research. The main funding source is the National Science Foundation, and ten percent is provided by industry.

The College of Engineering has a total undergraduate enrollment of 1,200 students, most of which are full-time. Approximately 90 percent are male. There are about 400 graduate students (5% female) and approximately 40 are part-time. It is estimated that 350 students annually complete the baccalaureate requirements and 100 students earn advanced engineering degrees. In Civil Engineering, twenty students were enrolled in the Master's programs in the fall of 1976, and eight students were enrolled in the Ph.D. program. During the 1975-76 school year, 34 students earned undergraduate degrees, 19 earned Master's degrees and two students received the Ph.D.

Approximately twenty percent of the students receiving B.S. degrees continue directly to graduate schools. It is expected that all graduates obtain employment directly in their field and 70 percent obtain positions in the private sector. Although the university maintains a Placement Office, students are also very successful in obtaining employment through individual contacts.

PROGRAM PROJECTIONS

Emphasis in the environmental engineering program in future years will remain on industry and the attempt to solve environmental and energy, fuel substitution, solar energy, and increased coal use problems. The Civil Engineering Department has no intention of developing a separate undergraduate major in environmental engineering. No change is foreseen in the institutional arrangements for degrees, but an increased emphasis on energy/environmental problems is expected. One additional faculty member was recently added to the environmental engineering program in the Civil Engineering Department. He has a doctorate, and his research interests include air pollution, and specifically, in trace metals in aerosols.

COURSE DESCRIPTIONS

12-721 Dynamic Hydrology - A theoretical basis is provided for analyzing water movement within the hydrology cycle; survey of important principles used in the analysis of ground water flow with applications to basin-wide ground water management; the design of industrial and domestic land and deep well waste disposal systems and to the prevention of water problems in coal mining operations; and other topics. (9 s.h.)

12-722 Wastewater Treatment: Theory and Design - Theory and design of wastewater treatment unit operations including sedimentation, activated sludge, and biological filtration. Material covered includes biological process kinetics, and theory and practice of advanced wastewater treatment processes. The design of solid handling systems focuses on thickening, digestion, incineration, and terminal disposal facilities. Laboratory sessions illustrate chemical principles of dilute aqueous systems and provide familiarity with chemical measurements commonly used in water and wastewater engineering. (9 s.h.)

12-723 Water Resources Chemistry - A rigorous yet practical basis for applying the principles of chemical equilibrium and kinetic models and physical chemistry to a description of the composition of waters and to water and wastewater treatment processes. Laboratory sessions illustrate chemical principles of dilute aqueous systems and provide familiarity with chemicals measurements commonly used in water and wastewater engineering. (9 s.h.)

12-732 Special Topics in Environmental Engineering - Development and application of models for assessing environmental problems with an emphasis on air pollution. Both elementary and more advanced models will be discussed. Consideration will be given to causes and effects of air pollution, control technologies, energy consumption rates and costs, and the need for efficient data collection and management. The course also includes studies of modeling atmospheric transport of air pollutants from source to sink. Offered from time to time as demand warrants. (9 s.h.)

INSTITUTION: THE CATHOLIC UNIVERSITY OF AMERICA

PROGRAM: Civil Engineering
DEPARTMENT: Civil Engineering
DEGREE: Bachelor of Science (B.S.)

CONTACT: Dr. Timothy Kao
620 Michigan Avenue, N.E.
Department of Civil Engineering
The Catholic University of America
Washington, D.C. 20064
(202) 635-5163

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The four-year professional program leads to the Bachelor's degree in Civil Engineering, and is fully accredited by the ECPD (Engineers' Council for Professional Development). The program emphasizes the major career lines of civil engineering: structures and structural engineering, water resources and environmental engineering, and transportation and system engineering. The first two years are the same as other engineering programs, the third year introduces civil engineering specializations, and the senior year is marked by the large selection of program electives, a feature introduced for the students so they can pursue one or two specializations in depth or a diversified set of courses.

The facilities at Catholic University, known throughout the world, are made available not only to the faculty, but also to the undergraduates in the civil engineering program. Students are further encouraged to participate in the current research projects. Faculty thus are encouraged to make available to the students the results of the ongoing research activities. Catholic University presently has one of the best photoelasticity laboratories in which students conduct many dynamic tests which deal with impact, fatigue, and creep of metals; tensile tests of metals and plastics; and failure analysis of soils and concrete.

The program also offers workshops and seminars in construction management for professional engineers, and conducts a co-op program, in which the student works one semester and studies the other semester.

PROGRAM REQUIREMENTS

In order to enter the Civil Engineering program, students must meet University requirements. This includes an official report of scores recieved on the Scholastic Aptitude Test and three Achievement tests of the College Entrance Examination Board (CEEB), a transcript from the student's secondary school, and a recommendation from a counselor, principal, or teacher concerning the student's character. Once in the program, the student must take various required courses. A recommended program is outlined for students, but the student is carefully guided over the four-year period to ensure that his individual needs and special interests are met. The student is required to take several math and physics courses, plus chemistry, civil engineering and electrical engineering. Electives are offered in civil engineering and mechanical engineering courses.

Scholarships and financial aid are available through Department assistantships, the George Hyman Construction Company Scholarship, and through University scholarships. Forty percent of the students attending Catholic University receive financial aid.

CURRENT FACULTY, STUDENTS, GRADUATES

Currently there are nine members on the teaching staff, seven of these are full-time, eight of these are FTE, and two of these are adjunct. All nine do at least some research. The faculty receives its research funding from the National Institute of Health, the National Science Foundation, HEW, the Office of Naval Research, and through a contract with Water Resources Research Center in the Department of Interior.

There are seventy-two students enrolled in the program; sixty-two males and ten females, all full-time. The program attracts only a few "career change" students, and averages between fifteen and twenty graduates annually. The graduates are traced through alumni surveys conducted by the Alumni Department. It is found that thirty to forty percent of the graduates go on to further schooling. Of the remaining sixty to seventy percent, almost all go into employment in their field. One-half are privately employed and one-half are employed by the government. Those employed, found their jobs through personal efforts.

PROGRAM PROJECTIONS

The Department would like to expand the Civil Engineering program in the near future, specifically in the areas of Coastal Engineering and in Continuing Education for professionals. The Department would also like to offer new courses in professional advancement, but no new degrees are foreseen.

COURSE DESCRIPTION

(the following is a partial listing of courses)

Undergraduate courses:

CE 312 Theory of Structures I - Classification of structures. Criteria of stability. Degree of mobility of mechanisms. Equilibrium of statically determinate structures. Analysis of reactions and internal forces of statically determinate structures. Axial, shear, bending movement diagrams (qualitative and quantitative). Three-dimensional structural analysis. Trusses, cantilevered beams, three-hinged arches. Influence lines. (3 s.h.)

CE 361 Engineering Properties of Materials - Importance of materials. Factors governing material selection. Structure of materials, dislocations, grains, polymorphism. Mechanical properties. Mechanism of plastic deformation, slip, critical resolved shear stress fracture, hardness, ductility toughness, and their measurement. Fatigue of materials, creep, impact. Effects of environments, corrosion, temperature, erosion, wear, corrosion fatigue. Protection techniques. Manufacturing processes. Material selection. (3 s.h.)

CE 366 Soil Mechanics - Significance of soil properties in foundations. Internal forces in soils. Atterberg limits and soil classification. Normal and shear stresses in soils. Importance of soil properties and history of stresses in behavior of soils. (3 s.h.)

CE 372 Water Resources Engineering - An introductory course in hydrology and hydraulics which incorporates the following topics: the hydrologic cycle, measurement and interpretation of hydrologic data, estimating runoff, storage routing, reservoirs and dams, groundwater hydraulics and wells, open channel flow and flow in pressure conduits. (3 s.h.)

CE 395 Strength of Material Laboratory - Experimental determination of stress-strain curves of various materials, including tensile and compressive strengths and other material properties. Fatigue, hardness, Ixod impact, and cavitation erosion tests. Bending and torsion of beams. (3 s.h.)

CE 432 Laboratory Project - Students conduct laboratory projects under supervision of various faculty members. Experiments must be planned, instrumented, and results presented. (3 s.h.)

Graduate courses:

CE 501 Structural Mechanics I - Introduction to the theory of elasticity; plane stress and plane strain problems; stresses and strains in pressurized vessels; torsion; use of energy and variational methods in structural mechanics. (3 s.h.)

CE 590 Environmental Quality-Water Pollution - Pollutant classification and water quality standards: natural and manmade pollutants in fresh surface water and marine waters, chemical and physical nature of important water pollutants, thermal pollution, biological conditions prevailing in aquatic eco-systems, criteria for water quality standards. Transport of pollutants: sources, pathways, persistence, and fate of pollutants in estuaries, rivers, lakes, and oceans, hydrodynamic models, stratified flow and plume dynamics, numerical methods, physical and biological factors. Application to water quality, impoundment, thermal stratification in reservoirs and lakes, water quality control and management in reservoirs, oil spills on ocean surfaces. (3 s.h.)

CE 595 Water Supply Engineering - Introduction to the development of transportation, processing, and treatment of water and liquid waste; chemical and physical characteristics of surface and ground water; characteristics of municipal and industrial waste effluents; principles of design for physical, chemical, and biological uses; disposal of sludges and residues; socio-politico-economic aspects of water supply and pollution control. (3 s.h.)

CE 596 Sanitary Engineering and Water Quality Management - Theoretical and applied aspects of analysis and management of water and waste treatment processes of water and waste treatment processes of water quality control through systems analysis of the entire environmental water-shared system. (3 s.h.)

INSTITUTION: CHATTANOOGA STATE TECHNICAL COMMUNITY COLLEGE

PROGRAM: Environmental Technology

DEPARTMENT: Division of Engineering Technologies

DEGREE: Associate of Science in Environmental Technology

CONTACT: Mr. James Giesemann, Associate Professor
Chemical and Environmental Technologies
Division of Engineering Technologies
Chattanooga State Technical Community College
4501 Amnicola Highway
Chattanooga, Tennessee 37406
(615) 622-6262

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This associate degree program was implemented in 1971 as an air pollution control training program, under a two-year grant from the U.S. Environmental Protection Agency. Expansion took place in 1976, with course offerings being made available in the fields of water and waste treatment, and stream biology. Since that time, graduates have been considered qualified for a variety of occupations, including air, water and stack sampler; air quality, water quality, and laboratory technician; environmental inspector, researcher, or consultant; and pollution control equipment manufacturer and salesperson.

The Environmental Technology degree program is no longer functional, although several of the courses are offered at this time. The program's demise is attributed to the lack of student interest; job opportunities are rare, and pay scales are low in the environmental field for graduates of two-year programs.

PROGRAM REQUIREMENTS

High school graduation or the equivalent (GED) is required for entrance into the college. There were no special prerequisites for the Environmental Technology program.

This program and its sister program, Chemical Technology, shared freshman year requirements, which include thirteen quarter hours of chemistry, fifteen hours of mathematics, eight hours of physics, two hours of drafting, and three hours each of composition, public speaking, and introduction to environmental pollution. During the sophomore year, those choosing the environmental option in Chemical and Environmental Technologies were required to take twenty-four hours in environmental technology. Additional courses during this year included the fields of chemistry, biology, computer science, electronics, English, and humanities. The number of quarter hours required for graduation in the environmental option was 105.

During a portion of its operational phase, the program cooperated with the Environmental Protection Agency's sampling network in the vicinity. Students assisted with sampling, and were paid for their efforts.

CURRENT FACULTY, STUDENTS, GRADUATES

Three faculty members were responsible for the administration and teaching responsibilities of this program during its peak. At the present time, one of these persons spends part-time teaching the two courses that are still offered. These courses may also be dropped from the college's offerings during 1978.

There have been seventeen graduates from this program. The first graduating class had nine in environmental technology, and the number graduating annually in this field has decreased steadily since that time to the present level of zero. Recruitment efforts were carried out, however, which included visits to local high schools, presentations at annual science fairs in local malls, and various other publicity. Nearly all those that have graduated from the program have found employment in the field, most in governmental agencies.

PROGRAM PROJECTIONS

Officials hope to keep the program functional to a small degree through a merger with Chemical Technology. Presently, this program offers more course work in the areas of organic chemistry, quantitative analysis, instrument analysis, and unit operations than had Environmental Technology. By combining these programs such that students acquire more expertise in these areas, thereby becoming more marketable, and offering several courses in environmental technology, students would be able to obtain skills necessary to enter environmental fields. Eventually, it is hoped that approximately ten persons will graduate annually in Chemical Technology that have taken environmental courses. This would keep the job market well supplied, if graduates would accept the low pay scales.

COURSE DESCRIPTION

ES 110 Introduction to Environmental Pollution - A brief introduction to the causes and effects of air pollution, the general methods of control, and governmental agencies and laws involved. Emphasis on effects. (3 q.h.)

ES 211 Meteorology and Climatology - A familiarization course covering general meteorology and climatology as applied to air pollution forecasting. An introduction to meteorological instruments. Effects of wind speeds, temperature inversions, and topography on air pollution levels. A visit to the National Weather Station. (5 q.h.)

ES 212 Air Pollution Control Methods - Introduction to the devices and methods for controlling the emission or particulates and gases from various industrial processes. A review of the operation of such equipment in local manufacturing plants. (4 q.h.)

ES 213 Environmental Sampling and Analysis I - A two-quarter sequence designed to acquaint the student with the problems of obtaining representative samples of the environment, and with the proper treatment of such samples to yield reliable information. Ambient air, smoke stacks, surface waters and sewage outfalls are sampled. Students perform the laboratory analyses by standard methods and visit installations where the work has been automated. (5 q.h.)

ES 214 Water and Wastewater Treatment - Purification of surface waters for municipal use with reference to the types of impurities to be removed and the methods of removal. Treatment of both municipal and industrial wastewaters. Trips to local treatment facilities to illustrate the size and operation of equipment. (4 q.h.)

ES 215 Air Pollution Laws and Regulations - Federal, state and local air pollution laws and regulations and the problems encountered in their enforcement. Coordinated with the local Air Pollution Control Bureau for practical problems in the field. (3 q.h.)

ES 223 Environmental Sampling and Analysis II - A continuation of ES 213. (5 q.h.)

INSTITUTION: CLARKSON COLLEGE

PROGRAM: Civil and Environmental Engineering

DEPARTMENT: Civil and Environmental Engineering

DEGREE: Bachelor of Science (B.S.); Master of Science (M.S.)
(in Civil and Environmental Engineering)

CONTACT: Dr. Norbert L. Ackerman
Chairman, Department of Civil and Environmental Engineering
Clarkson College
Potsdam, New York 13676
(315) 268-6529

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The undergraduate curriculum at Clarkson College in Civil and Environmental Engineering is designed to provide an understanding of the fundamental principles of mathematics, mechanics, science, and humanities on which engineering is based. During the junior and senior years the program concentrates on various subjects in the field of civil and environmental engineering and through the selection of electives, proficiency can be developed in particular areas of interest. Elective concentrations include the areas of environmental engineering and water resources engineering.

The Civil and Environmental Engineering Department also offers a graduate program in Water Resources and Environmental Engineering. Bachelor of Professional Studies, Master of Engineering and Doctor of Philosophy (Engineering Science) degrees are also available to students enrolled in the department. The majority of the graduates enter professional practice in the fields of civil and environmental engineering.

PROGRAM REQUIREMENTS

Undergraduate applicants are required to complete sixteen units of secondary school, including the following ten academic units for admission to the School of Engineering: four units of English; four units of mathematics; and two units of science (one unit each of chemistry and physics). Admission to the graduate program is granted to applicants with an accredited baccalaureate degree in civil engineering and exceptional students with bachelor's degrees in other engineering disciplines will be considered.

Candidates for the baccalaureate degree must complete a minimum of 120 credit hours, complete the physical education or military science requirement, and achieve a minimum cumulative grade point average of 1.850. A minimum of thirty credit hours is required for the master's degree and at least twenty hours must be earned in residence. No foreign language requirement exists for this degree. A thesis and a non-thesis option is available. Thesis credit accepted towards the degree cannot exceed ten hours of credit. Fellowships and assistantships are available to graduate students enrolled in the department. Many New York state residents are eligible for the Tuition Assistance Program which provides $100 to $1,500 per year.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of twenty-two faculty members contribute to the teaching of the department's curriculum. Twenty-one faculty are full-time. Research funding is provided from engineering foundations, private corporations, the U.S. Environmental Protection Agency, and the National Science Foundation.

There are currently (spring, 1978) an estimated total of 530 full-time students enrolled in the Department of Civil and Environmental Engineering (30 female). All students take at least one course in environmental engineering and approximately 20 to 30 percent (133 students) take two or more courses in this area. Enrollment has been consistently growing in the Department of Civil and Environmental Engineering and environmental engineering is considered to be a strong growth area. There are 25 students enrolled in the master's program, and approximately five are part-time.

At the baccalaureate level, there is an average of 120 students who annually receive the B.S. degree. Approximately eleven students annually receive the Master of Science degree. Of about twenty graduate students enrolled in the M.S. degree programs at any one time, twelve will graduate, six will drop out, and six will be enrolled as part-time students and take two to three years to complete the degree requirements.

It is estimated that 93 percent find employment that is directly related to their training, 4 percent in a related field and 3 percent find totally unrelated employment. The college's placement office is considered to have an excellent placement record. Placement statistics for 1975 and 1976 of Clarkson graduates show that over 77 percent were placed within three months of graduation. This includes 55 percent employed, 20 percent enrolled in graduate school, 2 percent engaged in military service, and 21 percent unreported. Of Civil and Environmental Engineering Department graduates, about 60 percent find private sector jobs and 40 percent find government positions.

PROGRAM PROJECTIONS

No changes in faculty staff or program structure are contemplated. No different degree programs are likely to be developed in the School of Engineering, as the college is at staffing and enrollment capacity.

COURSE DESCRIPTION (SELECTED)

Undergraduate courses:

CE 380 Environmental Engineering - An introduction to environmental engineering and environmental quality management. (3 s.h.)

CE 403 Civil Engineering Laboratory - A set of prescribed experiments is required related to the areas of mechanics, hydraulics, soils, materials and environmental engineering. (3 s.h.)

CE 479 Industrial Water Quality Management - A study of water supply and waste disposal problems of industry including technical and regulatory aspects. The nature of industrial wastes. Methodologies of industry waste surveys. (3 s.h.)

CE 484 Solid Wastes Engineering - The study of the principles of the collection, handling and disposal of municipal wastes, and disposal techniques including burial, composting, combustion, size reduction and densification. (3 s.h.)

CE 495 Special Projects in Civil and Environmental Engineering - An individual project is undertaken by the student under the guidance of a staff member. A complete report is required. (3 s.h.)

Advanced undergraduate and graduate courses:

CE 514 Groundwater and Seepage - Principles of confined and unconfined groundwater flow. Analysis by conformal mapping and graphical methods to determine the quantity of seepage, uplift pressures, and exit gradients. (3 s.h.)

CE 571 Water Resources - Consideration of physical, climatic, and economic geography; resources inventories; natural resource systems; conservation concepts; water supply and demand; economic, social and engineering objectives; water law, federal law, agencies, authorities and commissions; general principles of multiple-purpose regional planning; and other topics. (3 s.h.)

Graduate courses:

CE 671 Systems Design in Water Resources Development - Identification of design objectives in water resource development; system characteristics of a river basin; mathematical synthesis of hydrologic data; simulation and optimization; application to a multipurpose river basin system design. (3 s.h.)

CE 681 Water Renovation Processes I - The theory of the chemical-physical processes employed in water and waste treatment technology. The laboratory stresses pilot plant experimentation with emphasis on process design. (3 s.h.)

CE 686 Environmental Facilities Design - Emphasis will be on water supply, waste conveyance, and treatment facilities design. Topics to be covered will include water distribution system design, sanitary sewer system design, water treatment plant design, and waste treatment plant design. (3 s.h.)

CE 698 Graduate Thesis or Special Projects - Analytical or experimental studies under the direction of a faculty member specially designated. A grade and/or credit for this work presented in satisfaction of the requirements for a degree is given when those requirements are completed. (1-10 s.h.)

INSTITUTION: CLEMSON UNIVERSITY

PROGRAM: Environmental Systems Engineering

DEPARTMENT: Environmental Systems Engineering

DEGREE: Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Thomas M. Keinath, Professor and Head
Environmental Systems Engineering
Clemson University
Clemson, South Carolina 29631
(803) 656-3276

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Doctoral level education in environmental systems engineering at Clemson University began in the early 1960s, along with the development of the master's programs in this field. At the master's level, the M.S. and the M.Engr. degrees are offered under four areas of specialization: Air Pollution, Planning and Management, Natural Systems, and Water Treatment Systems. These programs are described in separate summaries in the appropriate volumes of this report.

The Ph.D. program is flexible, and is formed around the background and ultimate objectives of the candidate. Specialization may be elected in any of several areas within the boundaries of the environmental systems engineering field.

Doctoral-level ESE students become involved in research on an individual basis in the preparation of the dissertation, and may work in conjunction with faculty members in the conduct of sponsored research projects. The department has attracted over two million dollars of outside funding since its formation. Past and present research activities have been in such areas as wastewater treatment processes, water resources planning, reservoir limnology, lake enrichment, power plant siting, urban water quality, analysis of pollutants, environmental monitoring, ecosystem response, environmental quality assessment, dynamic modeling, and air pollution control processes. Funding for ESE projects has come from sources as the U.S. Environmental Protection Agency, the U.S. Army, several state agencies, and private industry. Departmental research facilities include twelve research laboratories, a precision analytical instrument room, a two-story unit operations and processes laboratory, and a hybrid computer.

Members of the ESE faculty have produced textbooks and authored numerous papers, and have chaired and keynoted sessions nationally and abroad. Continuing education workshops in upgrading sewage lagoon performance, industrial wastes, air and water pollution, and operator training have been presented as a public service to industries and governmental personnel. The faculty is also very active in participating on national boards and commissions such as the EPA Training, Research and Effluent Guidelines Committees, the National Wildlife Federation, and the South Carolina Board of Certification for Environmental Systems Operators. All faculty members are also actively involved with a number of state and national professional associations.

PROGRAM REQUIREMENTS

Unlike the ESE master's level programs, there are no predetermined standard prerequisites for acceptance into the Ph.D. program of study. Normally, a master's degree in a related field along with high academic achievement is a determining factor for acceptance. Students with master's degrees in fields other than environmental engineering who are enrolled in the curriculum normally must elect core courses from the ESE master's curriculum. Those with an M.S. or M.Engr. in environmental engineering from other universities normally audit these courses.

Work leading to the Ph.D. is planned in such a way as to give the student a comprehensive knowledge of his or her field of specialization and a mastery of research methods. The degree is not granted solely on the basis of course work completed, residence, or other routine requirements. Rather, the main basis for the granting of the degree is the student's grasp of the subject matter, the competency to plan and conduct research, and the ability to express himself/herself adequately and professionally in oral and written language.

Each student selects a major advisor, and an advisory committee is selected by the department head, the major advisor, and the student. This committee approves the student's curriculum, supervises the graduate program, administers the comprehensive examinations, and initiates recommendations for the awarding of the degree.

The Graduate School requires that Ph.D. candidates select at least half of their courses from those numbered 800 and above. A minimum of eighteen hours of doctoral research is also required. Doctoral students may, but are not required to select one or more minor fields and demonstrate competency in the chosen minor(s). Areas suitable for minor specialization are chemistry, biology, physics, mathematics, chemical engineering, economics, operations research, and management. Minor area course work should be chosen to enhance the development of the student's research program. A minimum of twelve to twenty-four semester hours is required to satisfy the minor area(s) requirement. Either by formal course work or by self-study, the students are also expected to become familiar with the use of computers and the basic principles of systems engineering.

At the end of the first year of study, all candidates must take a qualifying examination. Comprehensive examinations are scheduled after the completion of course work in the minor area(s) and upon completion of the broadening requirements. The function of these examinations is to obtain objective evidence of an adequate intellectual mastery of the areas of major and minor specialization. Passage of the examinations allows the student to apply for degree candidacy. The research phase of the degree program leads to a dissertation, which is prepared under the direction of the major advisor. The final oral examination demands a broad and penetrating interpretation by the student of the research project and its conclusions, and may include examination in the major and minor field(s) of specialization.

Approximately 95 percent of all ESE graduate students receive financial support. This comes from assistantships, fellowships, and various training grants.

CURRENT FACULTY, STUDENTS, GRADUATES

Seven full-time faculty members comprise the ESE department. Their teaching and research interests represent a broad range of topics and specialties within the broad field of environmental systems engineering. These faculty members all have responsibilities with the Ph.D., as well as the master's degree programs.

There are currently ten students enrolled in the ESE doctoral program. An average of approximately three completes the degree each year. Ph.D. graduates typically become faculty members of colleges or universities, or become expert researchers with private or governmental organizations. Others become administrators of environmental programs, also either in the public or the private sector.

PROGRAM PROJECTIONS

Within several years, the ESE Department's total enrollment is expected to grow from its present average of forty to forty-five, to approximately sixty. Some of this growth may take place in the doctoral program. Additionally, the ESE faculty will in the future place more emphasis on the control of toxic pollutants in the course work offered and in its research activities.

COURSE DESCRIPTION (GRADUATE ESE COURSES)

ESE 802 Principles of Water Treatment Systems - An intensive study of the fundamental principles that are of import to water and wastewater treatment systems. Topics discussed include the principles of biological and chemical reactions, mass and heat transfer, reactor kinetics, adsorption and ion exchange, ESE 802 (Cont'd) - clarification and thickening, transient response analysis and control theory, and methods of operations research. (4 s.h.)

ESE 803 Laboratory Principles of Water Treatment - Demonstrations and selected laboratory exercises which illustrate the fundamental principles of water and wastewater treatment systems. Typical topics include respirometer studies, reactor systems, dispersion, gas transfer, adsorption, thickening, and control systems. Emphasis on the relation between theory and experimental results. (1 s.h.)

ESE 804 Design and Operation of Water Treatment Systems - An investigation of the design and operational criteria that are significant to the processes employed for the treatment of water and wastewater. Topics include coagulation and flocculation, filtration, adsorption and ion exchange, membrane separations, chemical precipitation and water stabilization, chemical oxidation and disinfection, activated sludge, fixed film biological reactors, anaerobic digestion, solids handling and disposal, and municipal and industrial economics. (4 s.h.)

ESE 805 Laboratory in Design and Operation of Water Treatment Systems - Laboratory exercises in selected water and wastewater treatment processes. Coagulation, flocculation, filtration, reverse osmosis, softening, activated sludge, anaerobic digestion, and sludge handling and disposal are typical topics studied. Emphasis on the operation of these processes and on securing suitable design parameters. (1 s.h.)

ESE 806 Integrated Problems in Water Treatment Systems - Integration of the processes involved in water and wastewater treatment into complex systems. Emphasis on functional design and operation through consideration of process economics and plant control systems. The design and analysis of several integrated water treatment systems. (2 s.h.)

ESE 831 Air Quality Monitoring - Principles of ambient and source measurements or air pollutants. Siting of air pollution monitors. Laboratory exercises in source testing and ambient air analysis. (3 s.h.)

ESE 832 Air Pollution Meteorology - Applications of meteorology to air pollution. Topics include micrometeorology, plume rise modeling, atmospheric diffusion, deposition and washout of pollutants, air chemistry and applications of diffusion modeling to air quality planning. (3 s.h.)

ESE 846 Pollution of Aquatic Environment - A study of the effect of pollution resulting from domestic and industrial wastes upon the physical, chemical, and biological characteristics of natural waters. (3 s.h.)

ESE 847 Pollution of the Aquatic Environment Laboratory - Field and laboratory investigations into physical, chemical, and biological effects resulting from pollution of the aquatic environment. (1 s.h.)

ESE 848 Environmental Engineering Chemistry II - Applications of the principles of organic and biochemistry to the problems of environmental control, waste treatment, and bioengineering. (2 s.h.)

ESE 849 Environmental Engineering Chemistry Laboratory II - Theory and application of instrumental methods of analysis as applied to measurements for environmental control. Spectroscopy and spectrophotometric techniques, electrochemical analyses, chromatographic methods of analysis, and light scattering and electrophoretic measurements are discussed in detail and demonstrated in the laboratory. Demonstrations and selected experiments in interfacing and analytical instruments with the small digital computer are conducted. (2 s.h.)

ESE 860 Ecological Models - Systems analysis applied to ecology. Construction of models which predict ecological consequences of abuses to the environment. Frequency response analysis, energy models information flow, a transfer of functions for population interactions. (3 s.h.)

ESE 861 Environmental Systems Engineering Seminar - A discussion of current advances and research developments in various areas of environmental engineering. Off-campus speakers, students, and faculty participate. (1 s.h.)

ESE 862 Environmental Quality Case Study - An in-depth analysis and investigation of a significant current or recent situation affecting or involving some facet of environmental quality. The study is conducted by a team of students and results in a comprehensive position paper which integrates the pertinent social, political, and economic considerations in the case with the technical aspects. (1 s.h.)

ESE 881 Special Problems - Problems are selected in the field of environmental engineering to meet the interests and experience of student and instructor. (1-4 s.h.)

ESE 883,884 Selected Topics in Environmental Engineering - A comprehensive study of a topic in the field of environmental engineering that is not covered in another course. Topics covered vary to keep pace with current developments. (1-4 s.h.)

ESE 891 Research - Credit arranged.

ESE 991 Doctoral Research - Credit arranged.

INSTITUTION: CLEMSON UNIVERSITY

PROGRAM: Natural Systems

DEPARTMENT: Environmental Systems Engineering (ESE)

DEGREE: Master of Science (M.S.)
Master of Engineering (M.Engr.)

CONTACT: Dr. Thomas M. Keinath, Professor and Head
Environmental Systems Engineering
Clemson University
Clemson, South Carolina 29631
(803) 656-3276

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Environmental Systems Engineering at Clemson University grew out of a group of faculty members formerly housed within the Department of Civil Engineering. The mission of this group was to provide graduate level education of environmental engineering professionals in response to specific needs of the State of South Carolina. After four years, in 1966, a graduate program in Environmental Systems Engineering was formally established as a separate entity within the College of Engineering. In 1968, a formal ESE Department was established.

Originally, there were four areas of specialization within ESE: Water and Wastewater Treatment Systems, Natural Systems, Environmental Science, and Planning and Management. An Air Pollution specialization was added in 1976. The Environmental Sciences specialization was merged with Natural Systems in 1977.

At the master's level, the M.S. or the M.Engr. may be pursued within each area of specialization. The M.Engr. degree program is accredited by the Engineers' Council for Professional Development at the advanced level. A program of study for the Ph.D. is also offered, which provides more flexibility for specialization. Within these degree programs, emphasis is placed on applying the basic principles of the sciences and engineering to the design, operation, planning and management of man-made environmental control systems. These include water and wastewater treatment facilities, air pollution control devices, and the analysis and management of natural systems such as streams, estuaries, and impoundments, as well as the air environment. Those students choosing the Natural Systems specialization concentrate chiefly on the effects of pollutants on the aquatic environment. Course work provides the tools needed for predicting the fate of conservative and non-conservative pollutants discharged into bodies of water. Students may also select electives in such areas as radiochemistry, air pollution, and oceanography.

Since the formal organization of the ESE Department, it has attracted over two million dollars in external funding, including over one-half million dollars in training grant monies from federal and state agencies. Active research in natural systems/ environmental sciences includes dynamic modeling of natural aquatic systems, environmental impact assessment, stream and estuarine water quality surveys, development of automated instrumentation for environmental monitoring, tracking of toxicants in the environment, and development and application of automated analytical instrumentation for environmental monitoring. Students may become involved with research through special projects or as paid research assistants.

In addition to the direct education of graduate students and the conduct of research, the ESE faculty is of service to the state and region through several other means. Short-term training and re-training has been provided to citizens, governmental agencies, industries and consultants since ESE's inception in the form of workshops, conferences, seminars, and short schools. These have included the topics of coastal zone pollution management, air and water pollution control, industrial waste treatment, upgrading treatment using lagoons, stream surveys, water quality modeling, and impact statement preparation.

The faculty also participates in a wide variety of professional activities such as serving on relevant state and federal boards and commissions, assisting in the development of technical curricula and curriculum materials, presenting testimony before Congressional committees, participating in educational television and radio programs, authoring papers, and chairing national and international symposia. One faculty member has served as an expert advisor to the Environmental Protection Agency (EPA), and all faculty members are actively involved with professional environmental associations.

PROGRAM REQUIREMENTS

Admission to the ESE programs requires a bachelor's degree in engineering or a scientific discipline such as chemistry or biology. Non-engineers must have had prerequisite course work in mathematics through differential equations, one year each of chemistry and physics, and courses in computer programming, fluid mechanics, and general environmental engineering. Applicants for the M.Engr. degree program must have a B.S. degree in engineering from an ECPD accredited institution with at least a 3.0 cumulative grade point average on the last sixty semester hours to be eligible for acceptance. Engineers who have had at least two years of documentable professional engineering experience may be granted full admission provided they had an undergraduate grade point average of 2.5 or higher. All M.S. program applicants must have earned at least a 3.0 cumulative grade point average on the last sixty semester hours, and must have taken the Graduate Record Examinations with a score of at least 1000, for full admission. An engineering degree is not required for entrance into the M.S. program; applicants may be eligible with B.S. degrees in fields such as biology, physics, chemistry or mathematics, as long as prerequisite course requirements are met.

Thirty semester hours are required for the master's degrees. One calendar year is normally required for completion of these degrees, although working as teaching or research assistants can prolong the length of study. Each student selects a major advisor. An advisory committee, chosen by the department head, the major advisor, and the student, approves the student's graduate degree curriculum, supervises the graduate program, administers the final comprehensive examination, and initiates the recommendation for the awarding of the degree. The Graduate School requires that all M.S. programs include six semester hours of research if the thesis option is chosen. Most students take a two to three hour special problems course in lieu of the thesis. Of the remaining required hours, at least half must be selected from courses numbered 800 and above, for the M.S. degree. For the M.Engr., at least half of the required hours must be selected from courses numbered 700 and above. Students pursuing this degree must also complete a special project.

All ESE students take a core of courses specific to their area of specialization. The Natural Systems concentration requires that students take nine core courses, or twenty-two semester hours, which consist of the following: ESE 602, ESE 643, ESE 644, ESE 802, ESE 803, ESE 861, ESE 846, WRE 870, and WRE 875. Electives are chosen based upon individual career objectives. All core courses, as well as representative approved electives, are described below.

ESE master's candidates may select a minor area of concentration. These normally consist of at least six hours of credit in the chosen area.

The College of Engineering offers cooperative graduate programs with industry in which semesters of on-campus study are alternated with work assignments in industry. ESE students rarely participate in these programs, as they lengthen the term of study.

CURRENT FACULTY, STUDENTS, GRADUATES

The ESE Department consists of seven faculty members, all holding the Ph.D. degree, with teaching and research interests and responsibilities in diverse environmental fields. As faculty members' activities overlap into two or more of the areas of specialization, identifying the number of faculty for each area of specialization is not possible.

The current enrollment in the ESE Natural Systems area of concentration is six. The number of students enrolled in this program and in the department has remained relatively stable over the last five years. The number of graduates in the original Natural Systems concentration (before the merger) was four in 1976. The number of graduates with a concentration in Environmental Science during that year was one. Generally, ESE graduates with the M.S. degree are more likely to become employed by governmental agencies, while those with the M.Engr. are more likely to enter the private sector. Follow-up statistics on sixty-four ESE graduates of the years 1974 to 1977 have been assembled, which reveal that eight of the graduates became employed by industries, twelve by consulting firms, thirty-nine by governmental agencies (local, state and federal), and five continued their schooling for the Ph.D. These figures also include graduates with the Ph.D.

Approximately 95 percent of the ESE students receive financial assistance from a variety of sources, including research assistantships, teaching assistantships, and training grants. The department has had EPA training grants which have supported students in air and water quality.

PROGRAM PROJECTIONS

Although the department is close to reaching the maximum number of students it can accommodate with the space available, it is expected that within three years the overall enrollment will increase from the present average of forty to forty-five, to approximately sixty.

Program officials anticipate a shift of emphasis within the Natural Systems area of specialization. In anticipation of increasing skilled workforce requirements of the Toxic Substances Control Act of 1977, in both the private and public sectors, there will be an expanded emphasis on the study of the effect of pollutants on the natural environment.

COURSE DESCRIPTION

Core courses:

ESE 602 Water and Waste Treatment Systems - Study of the fundamental principles, rational design considerations, operational procedures of unit operations and processes, physiochemical and biological treatment techniques. Introduction to integrating unit operations and processes into treatment systems. (3 s.h.)

ESE 643 Environmental Engineering Chemistry I - Study of the fundamental principles of physical and analytical chemistry applicable in treating waters and wastewaters: chemical thermodynamics, chemical kinetics, acid-base equilibria, complex equilibria, electrochemistry. (2 s.h.)

ESE 644 Environmental Engineering Chemistry Laboratory I - Demonstration of principles discussed in ESE 443 and laboratory exercises in analytical methods used in water quality control. Wet-chemical analytical techniques include residue analysis, turbidity, color, alkalinity, acidity, pH, hardness, iron, manganese, dissolved oxygen, biochemical oxygen demand. Modern instrumental and electroanalytical techniques commonly incorporated in environmental water quality monitors. (2 s.h.)

ESE 802 Principles of Water Treatment Systems - Intensive study of fundamental principles of import to water and wastewater treatment systems. Topics include principles of biological and chemical reactions, mass and heat transfer, reactor kinetics, adsorption and ion exchange, clarification and thickening, transient response analysis and control theory, and methods of operations research. (4 s.h.)

ESE 803 Laboratory in Principles of Water Treatment - Demonstrations and selected laboratory exercises to illustrate fundamental principles of water and wastewater treatment systems. Respirometer studies, reactor systems, dispersion, gas transfer, adsorption, thickening, control systems. (1 s.h.)

ESE 846 Pollution of Aquatic Environment - Study of the effect of pollution resulting from domestic and industrial wastes upon the physical, chemical, and biological characteristics of natural waters. (3 s.h.)

ESE 861 Environmental Systems Engineering Seminar - Discussion of current advances and research developments in various areas of environmental engineering. (1 s.h.)

WRE 870 Stream and Estuarine Analysis - Physical, chemical and biological processes and relationships which exist in streams and estuaries; estuarine environment, free-flowing streams, mechanisms which describe transport of conservative and non-conservative materials through estuarine systems; estuary as a resource and techniques for its management. (3 s.h.)

WRE 875 Water Resources Planning - Water resources planning emphasizing river basin and regional aspects; purposes and objectives of water resources development, historical review of water resources development in the U.S., changing emphasis over time, current practice and guidelines as well as new approaches and techniques, public and private sector involvement in water resources planning and development, formulation of alternative plans and their analysis, public participation and resolution of conflicts, institutional and social dimensions of water resources planning and plan implementation, water quality and water quantity and their interactions. (3 s.h.)

Selected Approved Electives:

ESE 849 Environmental Engineering Chemistry Laboratory II - Theory and applications of instrumental methods of analysis as applied to measurements for environmental control. Spectroscopy and spectrophotometric techniques, electrochemical analyses, chromatographic methods of analysis, light scattering and electrophoretic measurements. Demonstrations and experiments in interfacing analytical instruments with small digital computer. (2 s.h.)

CH 691 Introduction to Radiochemistry - Study of natural and synthetic isotopes, including atomic and nuclear structures, properties of radiation, tracer techniques and applications. Laboratory includes methods of detection and measurement of radiation and applications of tracer methods. (3 s.h.)

CHE 462 Air Resources Engineering - Basic study of important aspects of control and utilization of air environment. Air pollution sources and effects, monitoring procedures, dispersion models, engineering controls, economics of control. Legislation and enforcement principles. (3 s.h.)

WRE 660 Physical Oceanography - Integrated treatment of the fluid dynamic, ecologic, geologic, and resource aspects of physical oceanography. Basic principles of physical aspects of oceans with techniques for application. Emphasis on relating oceanographic phenomena to relevant problems. (3 s.h.)

WRE 865 Hydrology I - Hydrologic cycle as hydrologic system; deterministic hydrology; all aspects of physical hydrology emphasizing balanced approach to ground water hydrology and surface water hydrology; meteorology, infiltration, soil moisture, and evapotranspiration; probability analysis and partial system synthesis by unit hydrograph techniques. (3 s.h.)

WRE 872 Marine Pollution Control - Current technology and problems related to water quality management in the marine environment; coastal and estuarine problems; submarine outfall systems, disposal of dredged material and wastewater sludges, thermal and oil pollution, water quality instrumentation, monitoring, and surveillance in the marine environment, design of oceanographic surveys required for water quality control. (2 s.h.)

WRE 876 Water Resources Systems - Water resources systems area; application of current operations research and systems engineering techniques and their use in analysis, evaluation, design, operation and management of water resources systems; water quality systems, hydrologic systems, integrated multipurpose systems including reservoirs, regional environmental control systems, power-generating facilities, industrial water supply and pollution abatement systems. (3 s.h.)

INSTITUTION: CORNELL UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Environmental Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)
Master of Engineering (Civil) (M.Eng.) (Civil)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Charles Gates
Department of Environmental Engineering
Cornell University
Ithaca, New York 14852
(607) 256-3658

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering is a major program of the School of Civil and Environmental Engineering and offers both undergraduate and graduate degrees. At the graduate level, a student may concentrate in one of five areas: environmental quality engineering, fluid mechanics and hydrology, public and environmental systems engineering, transportation, and water resources planning and analysis (Ph.D. only).

The current program grew out of a sanitary engineering program which began in the early twentieth century. It is now interdisciplinary in nature and several faculty members hold joint appointments within the Department of Environmental Engineering and various other departments in the university. Degree programs are flexible and allow students to pursue subjects relating to their interests.

Several support facilities are available in conjunction with the program. These include special laboratories in sanitary engineering, hydraulics and hydrology, and transportation, as well as computer terminals and computerized data resources. In addition, an interdisciplinary research center cooperates with the Department of Environmental Engineering: the Center for Environmental Research.

PROGRAM REQUIREMENTS

Admission to the B.S. program requires a high school diploma with at least sixteen units (one unit is equivalent to one year of study) of college preparatory subjects. These must include four units of math, one of physics, and one of chemistry. The remaining units are normally in English, foreign language, history, social science, and natural or life sciences. Prospective candidates are requiredto take either the Scholastic Aptitude Test with achievement tests in math and physics or chemistry or the American College Testing program.

For entry into the M.Eng. program a student must have a baccalaureate degree from an accredited engineering program or its equivalent in an appropriate area of engineering or science. Cornell graduates must have a cumulative grade point average of 2.5/4 or petition for entry if average is lower. Graduates of other schools must provide evidence of undergraduate preparation equivalent to Cornell's, two letters of recommendation and a statement of academic purpose.

Requirements for admission to the M.S. and Ph.D. programs stipulate that applicants must hold a baccalaureate or equivalent degree from a college or university of recognized standing.

The undergraduate degree program is designed to provide a student with an introduction to civil and environmental engineering technology and the opportunity for liberal study. A minimum of one-hundred and twenty-six credits are required for the degree. The first two years are spent in a Basic Studies Program which includes the requirement that two engineering core science courses be taken in each term of the sophomore year. Mechanics of Solids is required as one of the courses and it is recommended that Introductory Engineering Probability and either Dynamics or Mechanical Properties of Materials be taken as two of the remaining core courses. Students with special interests can depart from the third and fourth year curriculum and develop their own program in consultation with a faculty advisor.

The M.Eng. program is one year in length and is designed to prepare students for careers as professional engineers. A minimum of thirty credit hours of graduate level work are required along with an engineering design project and a formal report on the project. Four specific courses are required, two in Professional Practice in Engineering, and two in Civil and Environmental Engineering Design Project. The remainder of the program is designed by the student in consultation with an academic advisor.

Both the M.S. and Ph.D. degrees require work in major and minor areas of concentration, such as the five areas mentioned previously. These degrees also require a thesis on research conducted under the direction of a faculty member. The M.S. and Ph.D. programs are designed for students seeking careers in academic or research work.

CURRENT FACULTY, STUDENTS, GRADUATES

Currently there are four faculty members assigned to the program, each of whom teaches about one-half time and conducts research about half time. Research funding for the program has come from various sources including the National Science Foundation, the Office of Water Research and Technology (Department of the Interior), the New York State Energy Office, The Ford Foundation, and EPA.

Fifteen full-time students are enrolled in the undergraduate program and eighteen full-time are in the graduate programs. It is estimated that about half of the students come from the east coast area even though no data is kept on in-state/out-of-state students. Recruitment by the program is informal and accomplished primarily through faculty contacts with other schools and advertising via announcements and brochures. Most students are receiving some form of financial assistance, especially at the graduate level. Sources include EPA training grants, teaching and research assistantships, and engineering scholarship funds. There are approximately fifteen bachelor's degrees awarded each year and an equal number of gradaute degrees. These figures are down slightly from the number of graduates in previous years. Officials estimate that about seventy-five percent of the B.S. graduates go on to graduate school while only about ten percent of Master's degree candidates continue their education. Most of the B.S. graduates, about eighty percent, find employment in private industry or consulting firms and approximately seventy-five percent of the graduate students work in the private sector. A large part of the remaining graduates find positions in the government. Generally, students are placed in positions through faculty contacts and through the university and College of Engineering placement services.

PROGRAM PROJECTIONS

It is anticipated that program levels will remain stable with no increase in students or faculty forseen.

ADDITIONAL INFORMATION

Program officials conduct a one week summer educational seminar on industrial waste engineering, primarily for industry officials. Another seminar, on solid waste management, is being planned for industry and regulatory agencies.

COURSE DESCRIPTION

(the following is a partial listing of courses)

IIE 301 Environmental Quality Engineering - Introduction to air, water, and solid waste aspects of environmental quality envineering with emphasis on water quality concepts, theory, and methodology. (3 s.h.)

IIE 602 Water-Quality Control - Biological, chemical and physical fundamentals underlying water and wastewater treatment and their application of the analysis and design of processes for the treatment of natural waters and of wastewaters. (3 s.h.)

IIE 610 Chemistry of Water and Wastewater - Principles of physical, organic, inorganic, and biochemistry applicable to the understanding, design, and control of water and wastewater treatment. (3 s.h.)

IIE 620 Environmental Quality Control - Environmental pollution problems: their nature, causes, and effects. Concepts, phenomena, and methodology fundamental to protection of the air-land-water environment. (3 s.h.)

IIE 630 Solid Waste Management - Study of municipal, industrial, and agricultural solid wastes. Emphasis on waste characteristics, methods of treatment and disposal, and interrelationships with air, water, and land environment. (3 s.h.)

IIE 631 Industrial Waste Engineering - Characterization of liquid gaseous, and solid industrial wastes; their effects on receiving media. Treatment and disposal alternatives. Legislative and regulatory aspects of industrial waste control; industrial effluent guidelines and limitations. (3 s.h.)

IIE 633 Environmental Quality - An introduction to environmental quality and pollution problems: their nature, causes and control. (3 s.h.)

IIE 634 Air Quality Control - An introduction to air quality and air pollution porblems. Sources, natures, and effects of specific air pollutants; their dispersion and interactions in the atmosphere. (3 s.h.)

IIE 791 Design Project in Sanitary Engineering - The student will elect or be assigned problems in the design of water and wastewater treatment processes or plants; wastewater disposal systems; water quality control systems; water resource development or management systems. (variable s.h.)

IIC 609 Descriptive Hydrology - Introduction to hydrology as description of the hydrologic cycle and the role of water in the natural environment. (2 s.h.)

IIC 620 Analytical Hydrology - Physical and statistical analysis related to hydrologic processes. (3 s.h.)

IIB 619 Environmental Systems Analysis - Application of systems analysis, environmental engineering, and economics to environmental quality management systems. (3 s.h.)

IIB 747 Environmental Policy Analysis - Current research topics concerning the application of economic and simulation techniques to the definition and evaluation of public policy alternatives for managing air, land, and water resources and the material and energy wastes released into the environment. (3 s.h.) (3 s.h.)

IIH 615 Water Resources Problems and Policies - A comprehensive approach to water resources planning and development. (3 s.h.)

IIH 718 Water Resources Systems - Application of economics, engineering, and mathematical optimization and simulation models to river basin planning and regional development, hydropower and irrigation planning, reservoir operation, flow augmentation for quality control, watershed runoff, and other multiobjective, multipurpose water resources planning and management problems. (3 s.h.)

INSTITUTION: CORNELL UNIVERSITY

PROGRAM: Waste Management Engineering

DEPARTMENT: College of Agriculture and Life Sciences

DEGREE: Master of Science (M.S.)
Master of Engineering (M. Eng.)
Master of Professional Studies (M.P.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Raymond C. Loehr
Director, Environmental Studies Program
New York State College of Agriculture
and Life Sciences
Cornell University
Ithaca, New York 14853
(607) 256-2008

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Waste Management Engineering began in 1969 with initial emphasis on animal waste management. This has expanded to now include agricultural waste management, rural environmental engineering, non-point source pollution control, and land application of wastes.

This program is based in the College of Agriculture and Life Sciences. Four degrees are awarded, including the M. Eng. and M.P.S. which are professional degrees, emphasizing advanced work and project development. The M.S. and Ph.D. degrees however, emphasize original research and presentation of a thesis.

Facilities used in support of the program include several waste management laboratories, a pilot plant, large scale university and field facilities and the central computing system of the university.

PROGRAM REQUIREMENTS

Admission to the M. Eng. program requires that a student have a bachelor's degree from an accredited engineering program or its equivalent in an appropriate area of engineering or science. The M.S., M.P.S. and Ph.D. programs require applicants to hold baccalaureate or equivalent degrees from a college or university of recognized standing.

Requirements for the M. Eng. and M.P.S. degrees include thirty credit hours of graduate course work, of which six hours must consist of an engineering design experience involving individual effort and a formal report. No thesis is required. Program flexibility allows students to take courses of interest in a variety of subjects related to environmental and agricultural engineering.

The M.S. and Ph.D. programs are both extremely flexible in course requirements, allowing the individual student to choose his/her Special Committee, a faculty group which becomes solely responsible for his curriculum and research program. Original research and a thesis are required for either degree; M.S. students must take waste management as their major subject and select one minor subject from outside this area of specialization. The Ph.D. requires one major area of specialization and two minors, at least one of which must be in an engineering, agricultural, or basic science subject outside the field of specialization.

CURRENT FACULTY, STUDENTS, GRADUATES

The program faculty consists of four full-time and six part-time members, all of whom spend approximately one-half time teaching and one-half time in research. The program is the recipient of several sources of research funding, including EPA, the federal Departments of Energy and Interior, the National Science Foundation, the Rockefeller Foundation, and local farmer co-ops.

A total of eight full-time students are currently in the program, most of whom are from out of state. Students are recruited through faculty contacts at other institutions, brochures, and ads in professional journals. Most students are receiving some form of financial assistance, primarily research assistantships. Officials indicated that until three years ago, 80 percent of the students were supported by training grants and over a dozen full-time students were in the program.

An average of six students per year graduate from the program and this number is expected to remain constant. Only a small percentage of graduates continue on in school. Most graduates go directly into the workforce and have little difficulty finding jobs in their field, both in the public and private sectors. Generally, students are referred to jobs through faculty contacts.

PROGRAM PROJECTIONS

The program is not expected to increase in the near future. Capabilities exist for expansion, but officials indicated that increased financial support for students would be needed for expansion.

ADDITIONAL INFORMATION

Program officials conduct an annual waste management conference for officials of industry and government, and have developed a modular learning program in Land Application of Wastes to be offered in 1978.

COURSE DESCRIPTION (SELECTED)

471 Soil and Water Engineering - The application of engineering principles to problems of soil and water management. Design and construction of drainage, irrigation and erosion control systems, small reservoirs, and earth embankments. (3 s.h.)

475 Systems Models for Environmental Quality - Introduction to systems analysis techniques and their application to environmental quality management. (3 s.h.)

482 Environmental Control for Animals and Plants - Study of thermal interchanges between animals, including man, and plants with the environment. Understanding of physiological principles affecting thermal comfort and health. (3 s.h.)

675 Solid Waste Management - Study of municipal, industrial, and agricultural solid wastes. Emphasis on waste characteristics, method of treatment and disposal, and interrelationship with air, water, and land environment. (3 s.h.)

676 Industrial Waste Management - Legal aspects, assimilatory capacity of receiving water, joint industrial-municipal collection of wastes, and sewerage service charges. (3 s.h.)

677 Treatment and Disposal of Agricultural Wastes - Emphasis is on the causes of agricultural waste problems and on the fundamentals and application of possible treatment and disposal practices to control the problems. The course is aimed at having the students understand how to make decisions about selecting and utilizing appropriate agricultural waste management processes and systems, as well as how to design and operate the systems. (3 s.h.)

678 Environmental Quality Management for Agro-Ecosystems - The application of systems analysis and mathematics ecology to problems in ecosystem management and environment quality. (3 s.h.)

679 Use of Land for Waste Treatment and Disposal - The socio-legal-technical factors that dictate that disposal of wastes on land be a major alternative in all waste management schemes. (3 s.h.)

771 Soils and Water Engineering Seminar - Study and discussion of the management of agricultural waste, with emphasis on the physical, chemical, biological, economic, and aesthetic requirements. (1-3 s.h.)

INSTITUTION: DELAWARE TECHNICAL AND COMMUNITY COLLEGE

PROGRAM: Environmental Engineering Technology
DEPARTMENT: Applied Science
DEGREE: Associate of Applied Science

CONTACT: James T. Lober
Chairman of Applied Science Department
Delaware Technical and Community College
Stanton Campus
Rte. 7 and Churchman's Road
Newark, Delaware 19702
(302) 368-6984

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

First initiated in 1971, the Environmental Engineering Technology program prepares "Environmental Control Technicians" in the application of engineering principles in the fields of air and water. Graduates are especially qualified to conduct sample collections, laboratory analysis, treatment facilities design and operation and research and development. Students participating in the program receive an in-depth study of the basic sciences and receive training in skills in mathematics, chemistry, microbiology, and physics.

PROGRAM REQUIREMENTS

Delaware Technical and Community College has an open-door admissions policy although it is required to accept only high school graduates and applicants at least 18 years of age. There are no course prerequisites in order to enter this program.

Students are required to complete six quarter periods totalling 115 quarter hours of credit in order to earn the Associate in Applied Science degree. Included in the curricula are courses in advanced reading and study skills, technical mathematics, chemistry, technical report writing, probability and statistics, English, economics, and physics.

Students are eligible to apply for a variety of financial aid programs to help assist them in defraying their college expenses. This aid includes the typical Federal (e.g., National Student Defense Loans); Board of Trustee Scholarships; and work-study grants.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of four faculty members contribute to the offerings of the program's curriculum. The total include two part-time faculty and two full-time instructors.

There are currently (Spring, 1978) a total of forty students enrolled in the Environmental Engineering Technology program. Twenty are full-time and of these five are female students. Twenty students (14 full-time equivalent) are enrolled on a part-time basis and eight students are female. It is estimated that on the average, a total of ten students annually receive the A.A.S. degree over the past four years.

Most graduates continue taking classes offered in evening colleges while they are working. As part-time students they enroll at Widener College, the University of Delaware, Delaware State College, and the City College of New York. Program officials estimate that thirty percent of the graduates have found employment related directly to their training. Forty percent have found positions in a related field and less than one percent have found totally unrelated jobs. More than ninety-nine percent of the recent graduates have found private sector positions. Program officials consider the prospects for placement of graduates to continue to be very limited in the environmental field.

PROGRAM PROJECTIONS

Because of the lack of job opportunities over the past several years, the College is considering reducing the status of the program from a full degree program to an option attached to the Chemical Technology programs. No change in staffing of faculty is expected to result as this program is already structured in an interdisciplinary manner. College officials foresee increasingly poor opportunities in the environmental field at least at the A.A. Technician level.

COURSE DESCRIPTION

(the following is a partial listing of courses)

EV 141 Introduction to Environmental Engineering - Study of the major modes of environmental pollution. Technical, social, economics, political, and public health aspects of pollution problems and solutions are explored. (3 q.h.)

EV 143 Environmental Microbiology II - Specific areas of biology important in environmental control: soil, air, aquatic, domestic water and wastewater, food, milk, and industrial microbiology. (4 q.h.)

EV 243 Environmental Chemistry I - Study of physical and inorganic chemistry as specifically applied to the environmental field: color, taste, odor, coagulation, turbidity, solids, alkalinity, acidity, sulfates, chlorides, hardness, BOD, COD, etc. (5 q.h.)

EV 247 Industrial Waste Treatment - Study of various industries, their associated waste, and current treatment methods: food production, metal processing, chemical production, paper manufacturing, petroleum refining, etc. (3 q.h.)

EV 142 Environmental Microbiology I - Study of the biological organisms important in pollution control and public health: bacteria, fungi, algae, protozoa, etc. Laboratory includes microscopic inspection and identification, cultivation techniques, and standard analysis procedures. (4 q.h.)

EV 241 Environmental Control Process Design I - Study of the engineering principles and design criteria of basic air pollution control processes. Design of cyclone and impingement separators; spray chambers; cyclone, orifice, mechanical, venturi scrubbers; baghouses; electrical precipitators

EV 244 Environmental Chemistry II - Organic and biochemistry as specifically applied to the environmental field. Laboratory includes standard methods of analysis for greases, volatile acids, nitrogen forms, chlorine demand, phenols, COD, surfactants, etc. (5 q.h.)

EV 246 Community Air Pollution - Introduction to meteorology; sources, classes, and effects of atmospheric pollutants; prevention and control methods; laws, regulations, and standards. Laboratory includes basic monitoring instrumentation, sampling techniques, and data interpretation. (4 q.h.)

INSTITUTION: DELGADO COLLEGE

PROGRAM: Environmental Health Technology

DEPARTMENT: Environmental Health Technology

DEGREE: Certificate, Environmental Health;
Associate of Science (A.S.) in Environmental Health Technology

CONTACT: Dr. Sushil K. Gilotra
Chairman, Environmental Health Technology
Delgado College
New Orleans, Louisiana 70119
(504) 486-7393 x 305

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental health technology program at Delgado College was instituted in 1973. The major purpose for the establishment of this program was to provide practical knowledge of basic environmental health concepts, principles, methods, and techniques to state and local personnel. This program provides the graduates with the basic skills applicable to most areas of environmental concern.

In addition, the program provides continuing education for those persons already employed in the field.

Financial assistance, in limited amounts, is available to selected students in various forms.

PROGRAM REQUIREMENTS

The general environmental health curriculum is accomplished, usually, upon successful completion of a two-year course of study. In addition, students must spend the two summers (at the end of the first year and also at the end of the second year) involved in the environmental health practicum.

Requirements for conferral of the Associate of Science degree in environmental health technology include the following:

Course		Semester Hours
First Year:		
LAE 141/142	English	6
MAH 103/104	Mathematics	6

Course		Semester Hours
First Year (cont'd):		
SCC 103/104	Chemistry	4
SCB 101	Biology	3
EHT 101/102	Environmental Health	4
EHT 104	Industrial Hygiene	3
EHT 105	Food Service Hygiene	3
EHT 113	Water Purification	3
EHT 252	Vector and Rodent Management	3
	Total	35
Second Year:		
SSP 121	Psychology	3
SSS 151	Sociology	3
SCB	Approved Electives	3
EHT 207	Epidemiology	3
EHT 209	Microbiology	4
EHT 218	Environmental Monitoring	3
EHT 220	Air Pollution	3
EHT	Approved Electives	9
	Total	31

Therefore, in addition to the 66 semester hours of required course work, the student must also complete the environmental health practicum for six semester hours. The total semester hours reruired equal 72.

CURRENT FACULTY, STUDENTS, GRADUATES

Currently, the faculty allocated to the environmental health technology program includes three full-time teaching personnel. In addition, there are 10 part-time persons who assist with these programs.

The enrollment, at present, includes 41 full-time students. Of the 41 total, 28 are male and 13 are female. There are no current statistics available for part-time students. Graduates average approximately six annually.

PROGRAM PROJECTIONS

The environmental health technology program is anticipated, by the faculty, to illustrate growth over the next few years. In response to this growth in student population and in course offerings, one faculty member will be added to the staff during the next three to five years.

COURSE DESCRIPTIONS (selected)

EHT 101 Principles of Environmental Health - History, development, and philosophy of environmental science. Problems involving water

EHT 101 (cont'd) - supplies, sewage disposal, air pollution, solid wastes, swimming pools, industrial hygiene, occupational health, radiological health. (3 s.h.)

EHT 102 Institutional Environmental Health - Aspects of environmental health problems in instutions. Water supply, sewage disposal, and solid waste management. (1 s.h.)

EHT 103 Community and Institutional Health - Introduction to environmental and public health problems. (1 s.h.)

EHT 104 Industrial Hygiene - Recognition, evaluation, and control measures of problems associated with the hospital working environment. (3 s.h.)

EHT 110 Introduction to Radiological Monitoring and Civil Defense - Basic radiological monitoring information. (3 s.h.)

EHT 111 Solid Waste Management - Introduction to the fundamentals of solid waste characterization, handling, and disposal systems. (3 s.h.)

EHT 118 Environmental Monitoring I - Designed for environmental health, safety, and industrial personnel. (3 s.h.)

EHT 212 Radiological Health - Study of methods used in radiation detection, measurement, and handling of radioisotopes in the institutional and industrial environment. (3 s.h.)

EHT 220 Introduction to Air Pollution - The general field of air pollution. Emission, air pollution history, meteorology, atmospheric dispersions, effects on humans, and sampling and control equipment. (3 s.h.)

EHT 280 Industrial Environmental Health - Concepts and practices of industrial hygiene in sensing hazardous exposures and safeguarding the health of workers in industrial occupations. (3 s.h.)

EHT 105 Food Service Hygiene - Broad introduction to food sanitation, fundamentals of food protection and preservation, standards of quality, and sanitary requirements for production, processing, and distribution. (3 s.h.)

EHT 113 Water Purification - Basic principles of water purification. (3 s.h.)

EHT 114 Wastewater Treatment - Basic principles of elementary waste disposal by anaerobic and aerobic processes, quantities of waste flow, sampling and testing procedures. (3 s.h.)

EHT 130 Urban Environment - Non-technical course to discuss common and important facets of environmental health and how to improve life quality in urban areas. (1 s.h.)

EHT 150 Environmental Health Practicum I - Specific experience geared to career objective of student performed in a work and/or laboratory situation in environmental health under the guidance of a qualified environmentalist. (3 s.h.)

EHT 155 Pesticides and Spray Equipment - Course to familiarize students with chemicals and non-chemical agents to manage pests. Special emphasis is placed on the description and use of various spray equipment. (3 s.h.)

EHT 209 Public Health Microbiology - Microbiological testing, measuring, and evaluation systems used in food and milk hygiene, water quality, water pollution, and infection control. Prerequisite: Permission of department chairman. (4 s.h.)

EHT 250 Environmental Health Practicum II - Specific experience geared to career objective of student performed in a work and/or laboratory situation in environmental health under the guidance of a qualified environmentalist. (3 s.h.)

EHT 256 Impact of Urban Pests on Health - What and how diseases are transmitted by mosquitoes and other pests. Life cycles of disease agents and their control are discussed. (3 s.h.)

INSTITUTION: DREXEL UNIVERSITY

PROGRAM: Environmental Engineering and Science

DEPARTMENT: Multidisciplinary-Institute for Environmental Studies

DEGREE: Master of Science in Environmental Engineering
Master of Science in Environmental Science
Doctor of Philosophy

CONTACT: Dr. P.W. Purdom
Director of Environmental Engineering and Science Program
Institute for Environmental Studies
Drexel University
Philadelphia, Pennsylvania 19104
(215) 895-2265

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Initiated in 1963, the graduate program in Environmental Engineering and Science is offered by the Institute for Environmental Studies. A multidisciplinary program, the departments of physical sciences, engineering, and life and social sciences cooperate. The following areas of concentration are offered : Environmental Health; Environmental Planning and Management, Air Resources, Occupational Health; Water Quality and Resources; Solid Wastes; Environmental Assessment; and Environmental Chemistry. Other tracts of study may be developed where the preceding do not meet the student's needs.

Faculty and students utilize research facilities in various colleges for their work in environmental programs. The program's own laboratories include solid wastes, water and wastewater treatment, toxicology, environmental chemistry, and environmental rooms for the study of human behavior and reaction. Small incinerator studies using air flow equipment contained in a large incinerator room are conducted. An environmental library is located in Drexel's library and students have access to computer based abstract services (plotting facilities) and computer terminals. Much research is conducted in collaboration with government agencies and industries in the field. An example is a re-oxygenization study currently being conducted at a dam site in Georgia by a Drexel professor.

PROGRAM REQUIREMENTS

In order to enter this program a strong background in science and mathematics is necessary and applicants are requested to have at least two terms of college chemistry and differential and integral calculus. Students with this background are welcomed from all engineering fields, physical, life, and the social sciences.

The Master of Science in Environmental Engineering is awarded to students holding a Bachelor of Science degree from a curriculum accredited by the Engineer's Council for Professional Development. The Master of Science in Environmental Science is awarded to students possessing a Bachelor of Science degree. All Master's degree applicants complete 48 quarter-credits of course work and full-time students generally require 12 months to complete the program. All students also must complete a project or thesis of six to nine credits. Ph.D. students have a prepared individual course plan which is reviewed by a faculty committee which also administers a candidacy examination. After passing the candidacy examination, the student's research is supervised by a special faculty committee of at least five persons.

Most of the financial assistance provided to graduate students in the program consists of direct grants and fellowships. Drexel awards 15 traineeships supported by the U.S. Department of Health, Education and Welfare. The university supports one teaching assistantship and four to six students with research positions. One laboratory technician is hired by the program. The City of Philadelphia supports three students on a part-time basis.

Many part-time students receive tuition compensation from their employers in industry or government to attend night classes. Most industries in the area do not provide time off during the day to enable their employees to attend day classes so classes are rotated in the evenings.

CURRENT FACULTY, STUDENTS, GRADUATES

Thirty-seven faculty members participate in the teaching of the program's curriculum. Only ten to twenty percent of the staff do not participate in research activities and all faculty are required to teach. Faculty are involved in a broad range of basic and applied research in the following areas: Air Pollution and Air Resources; Water Quality and Water Resources; Solid Wastes; Ecology; Toxicology and Environmental Chemistry; and Environmental Management.

A total of 105 students are enrolled in the program during the fall quarter of 1977 and 69 are part-time(including Master's and Ph.D.). Fourteen students are conducting post-master's work and five passed their candidacy exams to begin work on their doctorates. Two female students are working on post-masters research; four to six are in the M.S. program and one is enrolled in the doctorate program.

During 1976, fifteen students earned the M.S. degree, twelve earned the M.S. in Environmental Science, and four received doctorates. Approximately ten percent of the program's graduates continue on for further education and less than ten percent of those continuing stay at Drexel University. One to two annually attend medical schools, a few go to Schools of Public Health (Michigan, Harvard, North Carolina, Florida) and others go on to various universities, such as, Stanford and the University of Illinois for advanced degrees. Virtually all graduates obtain employment directly in their field and it is estimated that 60 percent obtain private sector jobs and 40 percent find government positions. Most Ph.D.s obtain positions conducting research for industry or private research firms and few with doctorates work for government agencies.

PROGRAM PROJECTIONS

Enrollment has remained stable, although a slight decline has been detected by program officials. Most part-time students are enrolled in water pollution courses. Solid waste courses are now offered every other year. These courses have not been developed as a full-time program. The air pollution specialty may have to be dropped as a specialty area if the number of students enrolled in this area does not increase.

Most faculty additions are expected to result mainly from replacing staff members who have left. Recently, a civil engineer was recruited with an air pollution control engineering background. Two other faculty will be replaced by a civil engineer with a water quality engineering background and, a toxicologist recruited by the Biological Sciences Department to teach biochemistry courses.

Expansion of the program depends on the needs of cities and industry for short course in-service training. If expansion does become necessary, it will probably be in the areas of toxic and hazardous substances which are big health problems. Thirty or more students are enrolled in the occupational health specialty area without training grants as they perceive this as an area requiring future trained specialists.

COURSE DESCRIPTION (SELECTED)

F 202 Environmental Chemistry - Principles of physical and organic chemistry applicable to the study and evaluation of environmental conditions, especially the pollution of air, water, and soil. (3 q.h.)

F 208 Fate of Pollutants in the Air and Water Environment - The physical and chemical mechanisms that define the fate of a pollutant are theoretically delineated and applied to model environmental systems. (3 q.h.)

F 209 Advanced Environmental Chemistry - Thermodynamic and kinetic principles and their application to the study of chemical changes and reactions in the water or air environments. (3 q.h.)

F 214 Environmental Physiology - Effects of air pollutants, water pollutants and general environmental factors such as heat, light, sound, stress and activity upon the functions of the human respiratory, nervous, blood and excretory systems. (3 q.h.)

F 221 Environmental Health - Evaluation of environmental hazards, design of environmental controls for the health and well-being of man. (3 q.h.)

F 222 Epidemiology - Principles, purposes and methods of epidemiology; application of methods for the investigation of problems in the field of human diseases, infectious and noninfectious, emphasizing the relationship and equilibrium of host and environmental factors. (3 q.h.)

F 239 Toxicology - Acute and chronic effects of toxic substances and residues. Environmental exposures and controls. (3 q.h.)

F 241 Air Pollution Control Processes - Detailed study of the design and operation of air pollution control processes: settling filtration, inertial separation, scrubbing and precipitation. (3 q.h.)

F 243 Air Pollution Sources - Sources of air pollution will be considered in depth. (3 q.h.)

F 244 Air Resource Management - Component parts of air pollution control programs: air pollution standards, background survey, elements of air pollution control laws, misdemeanor and injunctive surveys, socio-economic surveys, and operation of an air resource management program. (3 q.h.)

F 252 Water Quality Control Laboratory - Analytical procedures used in the assessment of water quality as applied to the analysis of natural waters and to the control of water and waste water treatment processes. (3 q.h.)

F 255 Stream Analysis and Pollution Control - Fundamentals of limnology. (3 q.h.)

F 270 Solid Wastes Systems - An analysis of the public health, economic and political aspects in the operation and design of storage, collection and disposal of solid waste materials. (3 q.h.)

F 279 Environmental Project Analysis - Candidates for the master's degree in Environmental Science, or Environmental Engineering, are required to select an appropriate problem, formulate an approach to its solution, and then test this solution in so far as it is practical. (3 q.h.)

F 291 Research Methods - Introduction to research methods and literature, procedures for the collection and analysis of data; preparation of technical papers. (3 q.h.)

F 298 Thesis - Each student working on a dissertation will file a written report each quarter with his supervisory committee. A copy of this report must be filed with the Program Graduate Student Advisor. (2-12 q.h./term)

INSTITUTION: DUKE UNIVERSITY

PROGRAM: Civil Engineering/Urban and Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Civil Engineering
Master of Science in Urban and Environmental Engineering
Doctor of Philosophy

CONTACT: Dr. P. Aarne Vesilind, Director of Environmental Center
School of Engineering
Duke University
Durham, North Carolina 27706
(919) 684-2434

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Students pursuing the M.S. in civil engineering or the Ph.D. may specialize in any of the following areas: environmental engineering; geotechnical engineering and soil mechanics; mechanics of solids; materials engineering; fluid mechanics, water resources and ocean engineering; structural engineering; and urban systems and transportation. Also available are interdisciplinary programs combining study in some of the major areas with biological sciences, business administration, materials science, social sciences, political science, and other areas of engineering. Students may also select a special program leading to the M.S. in civil engineering and the A.M. degree in public policy sciences. The civil engineering degrees are accredited by the Engineers' Council for Professional Development.

A graduate option leading to the M.S. degree in urban and environmental engineering is also available through the Department of Civil Engineering. This option was created for non-engineers and for engineers with a non-civil engineering background who have a strong interest in the quantitative aspects of devising solutions to environmental problems.

A wide array of environmentally related research is carried out by faculty within the Civil Engineering Department. Areas of specialty include wastewater solids disposal, solid wastes, physical-chemical processes, urban systems, sanitary engineering design, engineering economics, unit processes, water resources, planning, water supplies, and water and wastewater drainage. Well-equipped laboratories are available to students for research projects, and thesis and dissertation preparatory work.

The Duke Environmental Center allows students and faculty in the various departments to expand upon research and learning activities in the environmental field. The purposes of the center are to focus attention on pressing environmental problems, to provide orientation and educational opportunities in environmental subjects, to promote interdisciplinary research, and to serve as a point of contact for the university, environmental agencies, and the public. The center sponsors a visiting speaker program, graduate and faculty seminars, and courses in environmental studies. The research efforts are aimed at the creation of multidisciplinary task forces in specific areas of environmental concern.

Engineering graduate programs are among the youngest at Duke University, but maintain very high student quality. In 1976, there were fifty-three applicants for every nine openings.

PROGRAM REQUIREMENTS

A minimum prerequisite to the graduate M.S. program in civil engineering is a basic knowledge of mathematics through linear differential equations, materials science, solid mechanics, and fluid mechanics. A grade point average of 2.7 on a scale of four is considered a guideline for admission to the program. The GRE is recommended, though not required. Admission to this program normally requires an undergraduate degree in civil engineering from an accredited institution.

Those with non-civil engineering backgrounds entering the urban and environmental engineering program must possess adequate undergraduate preparation. This includes: a minimum of four courses in mathematics, including two courses in differential and integral calculus, and two additional courses in mathematics, statistics, or an approved related area; a minimum of four courses in natural or physical sciences, of which at least two are in physics or chemistry; and a minimum of four social science/humanities courses, plus English I or the equivalent.

A minimum of thirty semester units of credit beyond the bachelor's degree is required for the M.S. degree in civil engineering. Twelve of these are in the major field, six in a related minor (usually mathematics or natural science), six in either the major or minor subject or in other areas approved by the department, and six for a research-based thesis. With departmental approval, students may take, in lieu of the preparation of a thesis, an additional six units of course work and a special project. Those choosing this option must take comprehensive examinations over their course work, and must orally defend their special projects.

The M.S. program in urban and environmental engineering is identical to the M.S. in civil engineering for those students with an engineering background. Students without an engineering degree are required to take two additional courses, which are usually designed to provide the necessary undergraduate background in urban and environmental engineering.

The Ph.D. degree requires at least sixty units of credit beyond the bachelor's degree. Twenty-four of these are required in the major field, twelve units in a related minor field, twelve in either the major or minor subject (or other approved areas), and twelve for a research-based dissertation. Doctoral students are required to pass qualifying and preliminary examinations, which are written, oral, or a combination of the two.

Students may receive credit for, as a portion of their minimum course work, courses offered by the Department of Environmental Sciences and Engineering of the University of North Carolina. While related course work is usually within the fields of mathematics or natural sciences, students may also elect courses in the social or managerial sciences if their interests lie within these fields.

Student financial support generally comes from two sources. The university's Graduate School hires a number of graduate students as research assistants, and research grants have provided support for many students.

CURRENT FACULTY, STUDENTS, GRADUATES

There are currently eleven full-time and four adjunct faculty members in the Department of Civil Engineering. Two full-time members and three adjuncts serve the environmental programs. All faculty members have both teaching and research responsibilities.

Twenty-six students are currently enrolled within the department. Of these, approximately one-half are in the environmental/urban and environmental engineering options. On a ten-year average, for the entire department, eight have received the M.S. degree annually, while four have received the Ph.D. each year.

While systematic student follow-up has not been carried out, department officials believe that every graduate has been successful at securing employment in his/her field. An estimated one-third of the graduates with the Ph.D. go into teaching, while the remainder enter research and consulting. It is also estimated that one-third of those earning the M.S. have become employed with governmental agencies, and two-thirds with private consulting firms. Few, if any of the graduates have continued their schooling.

PROGRAM PROJECTIONS

Program administrators foresee a need for expansion over the next five years; specifically, several new faculty members will be required. Additionally, discussion is underway regarding the possible development of a Cooperative College Program, allowing undergraduate students to begin the master's program in civil engineering following the junior year. Substantial additional funding would be required to carry out these forecasts, however, which is not available from the university budget.

It is particularly noteworthy that faculty in environmental engineering have recently developed a curriculum in resource recovery engineering. As reported in the October 1977 issue of the Journal of the Environmental Engineering Division, three new courses were developed: "Solid Waste and Resource Recovery Engineering", "Materials Design and Resource Conservation", and "Resource Recovery Systems Management".[1] The development of these courses was the result of the obvious need today for the development of trained and educated manpower in the area of reclaiming goods of marketable value from the waste stream. The faculty believes that resource recovery should become an integral part of many environmental engineering programs. The developed courses are abstracted below.

COURSE DESCRIPTION (Selected)

222 Open Channel Flow - Basic principles. Selected flow problems and practical solutions; gutter and inlet flows, flow over spillways, flow into estuaries and bays. Design of open channel structures, river hydraulics. Design of flood control and navigation structures; culverts, bridge openings, and energy dissipators. (3 s.h.)

224 Costal and Offshore Engineering - Basic analytical concepts; wave phenomena, theory of surface water wave motion, wave modification, and wave spectra. Effects of waves on structures emphasizing design of marine facilities. (3 s.h.)

225 Engineering Hydrology - Processes governing the origin, distribution, and depletion and replenishment of water resources, and application of this knowledge to the solution of water supply and drainage problems. (3 s.h.)

241 Environmental Engineering Chemistry and Biology - Inorganic and organic chemistry as applied to water and wastewater treatment. (3 s.h.)

247 Air Pollution Control - The problem of air pollution, with reference to chemical and biological effects. Measurement and meteorology of air pollution. Air pollution control methods, and law, noise pollution, and odor. (3 s.h.)

248 Solid Waste and Resource Recovery Engineering - Engineering design of resource recovery systems. Sanitary landfills and incineration of solid wastes. Energy recovery and recycling municipal refuse. Collection, treatment, and disposal of solid wastes from wastewater treatment. (3 s.h.)

249 Resource Recovery Systems Management - The social, economic, legal, political, and administrative aspects of resource recovery from municipal solid wastes. (3 s.h.)

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[1] Aarne P. Vesilind, "Resource Recovery Engineering Curriculum", Journal of the Environmental Engineering Division (October 1977): 761.

INSTITUTION: EAST CENTRAL OKLAHOMA STATE UNIVERSITY

PROGRAM: Environmental Science

DEPARTMENT: Environmental Science (School of)

DEGREE: Bachelor of Science (B.S.) in Environmental Science

CONTACT: Dr. M.L. Rowe
Assistant Professor and
Chairman of the Department
School of Environmental Science
East Central Oklahoma State University
Ada, Oklahoma 74820
(405) 332-8000

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

East Central Oklahoma State University instituted the Bachelor of Science degree program in environmental science in 1969. The program has undergone several revisions since the date of inception, and today is approved by the Accreditation Council of the National Environmental Health Association. At present, less than 25 colleges and universities are accredited by this association.

Program emphasis is directed at producing a graduate with broad-based training in environmental problems and solutions. The graduate of this program is a generalist, and thus, is able to pursue problems which may encompass a variety of pollution control and abatement issues.

The program faculty encourages students to conduct individual research projects, participate in appropriate field trip activities, and attend and participate in seminars and workshops especially as they relate to current developments, problems, and solutions.

A substantial number of research activities are presently being conducted through the School of Environmental Science. Selected students are invited to participate in these research projects. On-going studies are being conducted primarily in the inter-related areas of water and wastewater.

Historically, program graduates have found few obstacles to obtaining employment in occupations which span most of the environmental control areas such as water, wastewater and radiation. Graduates are qualified to enter occupations such as: air pollution monitor; solid waste systems manager; radiological health specialist; water/wastewater treatment plant technician; sanitarian; and, safety and sanitary inspector.

PROGRAM REQUIREMENTS

There are no special requirements for acceptance by the School of Environmental Science other than the satisfaction of university admission requirements and procedures. Most students enter the program at the beginning of the junior year. Approximately 35% of the entering students are transfers from Oklahoma junior colleges. East Central Oklahoma State University students are encouraged, however, to indicate environmental science as their major as early as the freshman year. Through early identification, students are advised to complete ES 1113 and ES 1213 prior to entering the program at the junior level. In the event that these two courses were not part of the student's lower division studies, they must be integrated into the upper division requirements.

Degree requirements include completion of a minimum of 124 semester hours of course work, at least 30% of which is in residence (on campus).

Having completed the appropriate lower division course work, as well as ES 1113 and ES 1213, the student enters the junior year with the following requirements for degree candidacy: (a) 11 semester hours of core courses (ES 3013, 3303, 3503, and 3102); (b) 21 semester hours chosen from the three orientation areas of health, (ES 3113, 3153, 4113, 4143, 4203, 4253, and 4994), environmental control (ES 3553, 3602, 4553, 4603, 4653, and 4994), and human ecology (ES 4353, 4403, 4453, and 4994); and, (c) 18 semester hours of an approved minor. The student must select at least 6 credit hours from the health orientation. Where 24 semester hours of biology, chemistry and physics have been completed the student is required to take only 16 semester hours in an orientation.

CURRENT FACULTY, STUDENTS, GRADUATES

Current faculty includes three full-time, cost-centered personnel. Teaching responsibilities are allocated as follows: one full-time environmental sciences, plus occasional chemistry; one half-time environmental health and half-time physics; and, one half-time environmental health and half-time biology.

Enrollment at present, totals 64 students. Of the 64 total, there are 47 male and 10 female full-time students, and seven part-time male students. In addition, there are four students from outside the School who have elected environmental science as a declared minor.

The number of graduates remained stable from 1972 through 1976 with 11 to 13 graduating annually. In 1977 the graduating students increased to 18. Most of the students choose a career path upon graduation. Approximately 18%, however, elect to pursue advanced degrees at institutions such as the University of Oklahoma and Oklahoma State University. Traditionally, the graduates of this program gain entrance to the chosen graduate programs. Those students entering the world of work at this level, are considered to be highly employable. The faculty is unaware of any graduate who was not successful in obtaining employment upon completion of the Bachelor of Science degree program.

PROGRAM PROJECTIONS

The faculty anticipates an approximate 5% per annum growth rate in the environmental science program. In response to this expansion and in an effort to increase the number of evening course offerings, the following personnel will be added to the current faculty, possibly by June 1978: one doctoral student in environmental health administration; one master's level state health sanitarian; and, one Ph.D. consultant from the U.S. Environmental Protection Lab at Ada. These three additional part-time faculty members will help to alleviate the evening teaching responsibilities of the regular faculty.

Students and graduates of this program have been increasing, on the average, over the last five years. Since the faculty has achieved the reputation of excellence for this program, every indication expresses growth and expansion. The approval by the Accreditation Council of the National Environmental Health Association has served to document the reputation of quality and excellence.

COURSE DESCRIPTION:

Core Courses:

Env Sci 3031 Introduction to Environmental Science - An overview of man and his environment is presented. The quality of water, air and food required by man and the removal of wastes from the environment are presented. (3 s.h.)

Env Sci 3303 Human Ecology - This course is an examination of the social aspects of man in a man-centered ecological system. Topics included are those of population, human culture differences and their varying effects on nature and institutions for environmental control (3 s.h.)

Env Sci 3503 Environmental Control - A survey of the various techniques which can be utilized in the management of the environment. (3 s.h.)

Env Sci 3102 Environmental Health Survey and Statistical Techniques - This course consists of classwork and a field experience. One hour each week during the semester is spent learning the rudiments of statistical analysis and in the planning of an environmental survey of a community. During the two week period immediately following the semester, the students will conduct the survey in a community in southern Oklahoma and analyze the results. (2 s.h.)

Env Sci 3113 Epidemiology (Health Orientation course) - A study of the etiology and characteristics of the principal diseases of man and the control of infected individuals and environment. Methods of presenting and interpreting epidemicity and endomicity are presented. (2 s.h.)

Health Orientation courses:

Env Sci 3153 Environmental Health Administration - The structure and administration of environmental health organization are covered. The legal and financial basis of programs and the management practices utilized in present programs are discussed. (3 s.h.)

Env Sci 4133 Institutional and Occupational Health - Recognition, evaluation and control measures of variable affecting the environmental health aspects of work habitats, schools, camps, hospitals, nursing homes, day care centers and other public facilities are presented. (3 s.h.)

Env Sci 4203 Community Sanitation - A lecture and laboratory study is made of the environmental functions performed by personnel in a typical city-county health department. Topics are discussed in the course including food and milk protection, swimming pool sanitation, measures for the abatement and control of pests, percolation tests for septic systems, sanitary surveys and health program aspects of air, water and solid wastes. (3 s.h.)

Environmental Control Orientation courses:

Env Sci 3553 Water Science - An integrative study of the occurrence properties, distribution and utilization of water in natural and man-made systems. (3 s.h.)

Env Sci 4553 Water Quality Surveillance - A preliminary study of water quality control in which the measurements and study of the biological and chemical factors affecting the aquatic environments are stressed. The processes used to treat water and wastewater are surveyed. Laboratory experience is also stressed. (3 s.h.)

Env Sci 3603 The Atmosphere and its Pollutants - This course is a study of both atmospheric phenomena affecting air pollutant responses and the characteristics of the common air pollutants. (2 s.h.)

Env Sci 4603 Air Pollution Control Processes - A study of the unit processes utilized in the cleaning of gaseous mixtures. Sampling and measurement techniques are presented. Laboratory experiences are stressed. (3 s.h.)

Env Sci 4653 Qualitative Aspects of the Urban Environment - The community environment is examined from the standpoint of sanitation and aesthetics. Solid waste, drainage, open space planning, noise suppression and community maintenance activities are also discussed. (3 s.h.)

INSTITUTION: EAST TENNESSEE STATE UNIVERSITY (ETSU)

PROGRAM: Environmental Health

DEPARTMENT: Environmental Health

DEGREE: Bachelor of Science in Environmental Health (B.S.E.H.)

CONTACT: Dr. Monroe T. Morgan, Chairman
Department of Environmental Health
East Tennessee State University
Johnson City, Tennessee 37601
(615) 929-4268

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This was the first B.S.E.H. to be accredited by the National Accreditation Council of the National Environmental Health Association and has since set the criteria for like accreditations elsewhere. Hunter College in New York and Colorado State University both modeled their curricula after ETSU's.

The environment is an ecosystem, none of the parts of which are able to function entirely unto themselves. Traditionally, people have been trained to work in one specific aspect of environmental maintenance, but very few were able to coordinate and choreograph the interaction of these separate activities to cooperate with the natural overlap which occurs in ecosystems. Graduates of this program are prepared to work in that precise area, the interface. These people are fit environmental program coordinators, environmental planners, environmental impact analysts, human ecologists, public health officers, environmental health administrators, consumer safety specialists, industrial hygienists, epidemiologists, milk and food technologists, water supply developers, environmental health instructors, accident prevention specialists and, as per tradition, sanitarians.

The generalist program was begun in 1966 and, while training will still be bent in the interface direction, additional needs have been recognized. Shortly, students will be able to decide between the traditional generalist curriculum or a specialist curriculum in air, water, solid waste, or industrial hygiene.

PROGRAM REQUIREMENTS

Graduates of approved Tennessee high schools are eligible for admission to ETSU. Out-of-state students must have appropriate college preparatory backgrounds, be in the top half of their graduating class, and, like in-state applicants, submit either American College Testing Program scores of Scholastic Aptitude Test scores. Applicants eighteen years of age or older, who are not graduates of an approved high school, may qualify for admission on the basis of an average score of forty-five on the General Educational Development Tests (GED) or on presentation of a GED diploma.

The university requires a core of fifty-seven quarter hours of general liberal arts courses such as English, speech, economics, psychology, sociology, art history, music, and others. This major calls for forty-one hours of math and sciences; specifically, eight hours of general biology, eight hours of chemistry, four hours of anatomy, four hours of physiology, four hours of physics, and nine hours of mathematics. Students may select twenty-six hours of courses in free electives.

Sixty-six hours of courses in the College of Health are needed for the major, these are: Personal Health, Introduction to Environmental Health, Principles of Epidemiology, Water Supplies and Wastewater Treatment, Environmental Control of Insects and Parasitism, Health Communications, Introduction to Air Pollution, Environmental Safety, Food Sanitation Principles, Solid Waste Management, Community Health, Environmental Health Aspects of Housing and Medical Care Facilities, Introduction to Radiological Health, Occupational Health, Introduction to Vital Statistics, Public Health Sanitation, Biological Foundations of Sanitation, Environmental Health Equipment, Environmental Analysis, and Environmental Health Program Planning. The entire program consists of one hundred and ninety-two quarter hours.

CURRENT FACULTY, STUDENTS, GRADUATES

Eight full-time people have charge of the Department of Environmental Health. There has been an administrative change in the university which has resulted in a campus-wide priority shift. This shift has placed increased emphasis on faculty persons having Ph.D.'s to facilitate research grant soliciting and also to enhance the staff expertise level in those departments offering or wishing to offer Ph.D.'s.

One hundred and forty-six undergraduate students are pursuing B.S.E.H. degrees. Fifty-nine percent of these students are Tennessee residents. Officials of this department hope that the enrollment is not permitted to expand much more than the present level.

During the academic year (AY) 1975-1976 there were sixty-three graduates of this program, and during AY 1976-1977 there were forty-seven. Even though there is a placement office on campus, its use is discouraged. Program sources say that the type of occupation which is usually listed there is for the traditional sanitarian. These graduates are qualified to perform that service, but the unique nature of their training has provided them with a level of skill which prepares them for a variety of occupations of which the placement service has little knowledge. As a result, this department has attempted to identify viable areas for graduates to pursue. As faculty members are contacted by potential employers, they post leads on a bulletin board for the students. These students must use their own initiative in seeking employment, but placements do exist and graduates have excellent success in securing them once they are identified.

Approximately 20 percent of the graduates continue their schooling. Of all of the three hundred and eighty-seven B.S.E.H. and M.S.E.H. graduates combined, approximately 8 percent have accepted placements with industry, another 5 percent are employed by health care institutions, 22 percent are enlisted in the military in related positions, and 65 percent are working with state or federal agencies.

PROGRAM PROJECTIONS

As has already been discussed, plans are underway to incorporate options for specialization. In addition to the specialization options it is hoped that an emphasis on occupational safety and health will be developed.

The most immediate development in this department is the addition of a Ph.D. option which will admit four or five students in the fall of 1979.

COURSE DESCRIPTION

Requirements:

1010 Personal Health - Various aspects of physical, mental, and social well-being. Attempts to create greater appreciation and understanding of health, which should be reflected in more intelligent self-direction of health behavior. (3 q.h.)

2310 General Microbiology - Bacteria and other microorganisms that have bearing on physical and economic well-being of man. (4 q.h.)

3000 Human Anatomy - Structure of the human body with emphasis on the relationship of structure and function. Skeletons, manikins, and slides are used for laboratory study. Rhesus monkeys are dissected. (4 q.h.)

3020 Human Physiology - Functions of cells, tissues, organs, and systems. Illustration of many physiologic processes. Human subjucts used in some exercises and laboratory animals used in others. (4 q.h.)

3060 Introduction to Environmental Health - Major areas of environmental health and areas of environment that come under the influence of the Sanitarian. Origin and progress of the environmental health field. Role of the sanitarian. (3 q.h.)

3080 Principles of Epidemiology - Introduction to principles of epidemiology and their application to investigation and measures for control and prevention of disease. (3 q.h.)

3100 Water Supplies and Wastewater Treatment - Introduction to water and wastewater treatment, municipal, semi-private and individual systems. Review of sources, chemical and bacteriological quality, and water pollution. (3 q.h.)

3240 Environmental Control of Insects and Parasitism - Importance of animal parasites and vectors in the spread of human disease. Emphasis on ways in which infections are contracted and spread, and methods of control. (4 q.h.)

3390 Health Communications - Designed to help the student to speak and communicate more purposefully in his/her profession. Includes study in outlining, writing for the press, practice in interviews, acceptable conversation, telephonic personality, acceptable written and spoken English, report preparation and report writing, public address and organization, methods in note-taking, and other professional communication considerations. (3 q.h.)

3400 Introduction to Air Pollution - Causes, effects, and control of air pollution. Emphasis on ways individuals, communities, metropolitan areas, and industry can prevent or control pollution. (3 q.h.)

3500 Environmental Safety - Principles and practices of environmental health and safety in natural bathing places, swimming pools, camp sites, parks, day nurseries, schools, colleges and universities. (3 q.h.)

3600 Food Sanitation Principles - Food composition, engineering principles, processing and preservation methods, food-borne diseases, and food regulatory programs. (3 q.h.)

3700 Solid Waste Management - Problems and solutions in generation, storage, collection, and disposal of solid wastes. Management aspects of planning, designing, organizing and operating refuse collection and disposal systems. (3 q.h.)

4030 Community Health - Health problems of communities and their causes. Work of various agencies concerned with community health, and the individual's responsibilities for community health. Health education. (3 q.h.)

4080 Environmental Health Practice - The environmental health aspects of nursing homes, schools, colleges, hospitals, camp sites, and recreational areas are studied. (3 q.h.)

4100 Environmental Health Aspects of Housing and Medical Care Facilities - Principles of healthful housing, and environmental control of hospitals, nursing homes, mobile homes, motels, hotels, penal institutions, and laboratories. (3 q.h.)

4200 Introduction to Radiological Health - Basic principles and procedures pertaining to safe control of all common sources of ionizing radiation. Causes, effects, and control of radiation are included. Laboratory experiments include safety monitoring, radiation detection, and use of survey meters. (4 q.h.)

4340 Occupational Health - Health problems encountered in industry and various occupations. Emphasis on causes of occupational diseases and ways to prevent the diseases. Introduction to types of radiation, with emphasis on controlling amount of radiation a person receives. (3 q.h.)

4360 Introduction to Vital Statistics - Statistical logic and elementary techniques of statistical analysis as applied to health. Collection and interpretation of population, natality, morbidity, and mortality statistics and elementary probability, sampling, and tests of significance will be considered. (3 q.h.)

4370 Public Health Sanitation - Critical analysis of environmental health principles, procedures, and practices. Emphasis on application of sanitary science in providing healthful environment. (5 q.h.)

4380 Biological Foundations of Sanitation - Basic principles of microbiology with emphasis on morphology, infection and effects of chemical and physical agents. Parasites and arthropods of medical importance, their recognition, life cycles, and methods of control. (4 q.h.)

4390 Environmental Health Equipment - Basic principles of physical factors necessary for practicing environmental health. Surveying, soil topography, hydraulics, pumps, valves, plumbing, chlorinators, pressure tanks, environmental design and environmental equipment. (3 q.h.)

4395 Environmental Analysis - Training in physical and chemical analysis of water, wastewater, food, air, and toxic materials. Experience in use of chemical instruments, as well as field test kits. (4 q.h.)

4400 Environmental Health Program-Planning - How to plan and evaluate environmental health programs. Availability of resources and relationship with other health agencies. (3 q.h.)

INSTITUTION: EAST TENNESSEE STATE UNIVERSITY (ETSU)

PROGRAM: Environmental Health

DEPARTMENT: Environmental Health

DEGREE: Master of Science in Environmental Health (M.S.E.H.)

CONTACT: Dr. Monroe T. Morgan, Chairman
Department of Environmental Health
East Tennessee State University
Johnson City, Tennessee 37601
(615) 929-4268

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This program began as an outgrowth of the Bachelor of Science in Environmental Health in 1971. While the primary thrust of this department is to train personnel who are capable of coordinating and communicating with various specialists in environmental disciplines, two options for study are offered. Administrative Option graduates are qualified environmental program coordinators, environmental planners, environmental health administrators and human ecologists. Graduates of the Specialist option will be qualified in one of the four disciplines: air pollution specialist, water pollution specialist, solid waste specialist, or industrial health specialist. Career potential for the specialist exists in the fields of consumer safety, milk and food technology, insect and rodent control, public health, solid waste management, air pollution control, water and wastewater management, or industrial hygiene.

This was the first M.S.E.H. to be accredited by the National Accreditation Council of the National Environmental Health Association and has since been the model for environmental health program accreditation criteria at the graduate level.

During each spring quarter, one of the department's three laboratories is designated for graduate thesis research only to allow students to work undisturbed. The Veteran's Administration Hospital is adjacent to the ETSU campus and provides additional support.

PROGRAM REQUIREMENTS

In order to be eligible for graduate study, the student must have completed a baccalaureate degree from an accredited institution with a 2.5 grade average (on a 4.0 scale). Students entering the specialist program must have taken at least thirty quarter hours of health, biological, physical, and/or sanitary sciences and having had work experience is desirable. Those in the administrative option must have had a minimum of three years of environmental health field experience. Undergraduate deficiencies must be completed prior to admission to the graduate program.

General requirements for a major include forty-two quarter credits of specified courses in the department and approved electives. Additionally, three hours of research and three hours of thesis work are required. Each student must pass a final oral examination which is primarily a thesis defense but is not limited to it.

A minor may be completed with eighteen hours of courses at the graduate level which have been approved by the student's committee member from the department.

CURRENT FACULTY, STUDENTS, GRADUATES

Eight full-time and one part-time faculty comprise the teaching staff of this department. Involvement in research is marginal although this may be expected to change in the near future. A new university administration is giving priority status to developing an active research effort in this and other departments on campus.

There are forty students enrolled in this program, fifteen of whom are in the administration option. Given the current faculty size and teaching/research facility, this is the ceiling enrollment anticipated. Since 1971 there have been an average of twenty-four persons graduating each year (one hundred and sixty-six in all). Approximately 90 percent of the students receive some type of financial assistance. A sampling of the agencies providing support are the United States Army, the World Health Organization, and Aramco.

Because of the traditional concept of environmental health graduates as being sanitarians, use of the university placement office is discouraged. Employment leads are registered through the department itself and students have had good results in locating appropriate positions. Of a total of three hundred and eighty-seven graduates traced, eighty-seven enlisted in the military, thirty accepted positions with industry, twenty with health care institutions, and two hundred and fifty are with state and federal agencies. Two people pursued Ph.D.'s following graduation.

PROGRAM PROJECTIONS

Approval is being sought and plans are underway for a Ph.D. program in environmental health. Plans are to admit four or five Ph.D. candidates in the fall of 1979.

The specialist's option will soon include the topic of energy in keeping with the focus on our national need for new and environmentally sound methods for energy production.

Sources indicate a critical need for persons who are skilled in environmental land use planning, and the expertise for curriculum development along this line exists at ETSU. Not only at ETSU, but everywhere, professional developments must be brought into the classroom more quickly. It is also felt that the industrial involvement potential should be tapped in order to provide practical experience for the students. A primary development is the effort to change the widely accepted concept of environmental health graduates being qualified to fill no other occupation than that of sanitarian.

COURSE DESCRIPTION

Core Requirements for Administrative and Specialist Options:

5100 Environmental Health Practice I - Private and public sewerage and water systems, storage, collection and disposal of solid wastes. Field trips to local facilities. (3 q.h.)

5110 Environmental Health Practice II - Principles and practice in Public Health supervision of food and milk programs. Sanitary aspects of production, processing, handling, storage, and transportation of foods. (3 q.h.)

5300 Biostatics and Epidemiology - Techniques of collection, summarization, presentation and analysis of public health data. Epidemiology in solving health problems. Lecture and laboratory. (4 q.h.)

5870 Environmental Health in Public Law - Orientation to fields of Public Health and Environmental Health including historical background, human ecology, sanitation, public health laboratories, epidemiology, communicable disease control, and special services of each field. (3 q.h.)

5960 Thesis - (3 q.h.)

Specialist Option:

5200 Environmental Chemistry - Inorganic, organic, qualitative, quantitative and biochemistry for environmental control. (4 q.h.)

5650 Environmental Microbiology - Biology, microbiology, biochemistry, and physiology as they pertain to environmental health. (4 q.h.)

Air Pollution Specialist:

5500 Air Pollution Principles - Introduction to field of air pollution including sources, emissions, atmospheric dispersion, 5500 (Cont'd) - effects on humans, materials and control equipment. (3 q.h.)

Water Pollution Specialist:

5600 Water Pollution Principles - Sources, causes and effects of water pollution. Emphasis on methods of control of physical, chemical and biological factors. (3 q.h.)

Industrial Health Specialist:

5700 Industrial Hygiene - Occupational disease hazards and preventive measures for control including exposure to dusts, gases, vapors, fumes, and mist. Field trips to industry. (3 q.h.)

Solid Waste Specialist:

5840 Solid Waste Management - Problems and solutions to storage, collection and disposal of solid waste. (3 q.h.)

Courses Required in Administrative Option:

5860 Environmental Health Administration - Organizational structure, forces of management, administrative controls, personnel and financial management, legal aspects of environmental health programs and organizations. Lecture, discussion, seminar and group exercises. (3 q.h.)

5880 Environmental Health Management - Continuation of 5860 with emphasis on environmental management practice by use of case studies, group dynamics, the incident process, the in-basket exercises, the political process, and the executive process. (3 q.h.)

5890 Environmental Planning - Planning process of the environment as it relates to health and welfare of the community. (3 q.h.9

Political Science 5730 Urban Government - Research into problems and challenges facing urban American society. (3 q.h.)

Graduate Electives:

5140 Principles of Sanitary Science - Fundamental basis of sanitary science to establish interrelations and applications of mathematics, 5140 (Cont'd) - physics, fluid mechanics in the control of the environment. (3 q.h.)

5400 Consumer Protection and Environmental Design - Introduction to principles, methods and programs of consumer protection. Emphasis on household products, appliances and environmental design as to promote safety and positive health in the community. (3 q.h.)

5510 Air Pollution Control - Specialized, technical aspects of air pollution control, including sampling from ambient air and stacks, analysis techniques, meteorological considerations, dispersion of stack effluents, control technology, and others. (3 q.h.)

5610 Water Pollution Control - Specialized technical aspects of water pollution control including dissolved oxygen relations in streams, techniques of sampling and analysis, water pollution control surveys, considerations in the design of water pollution control facilities, mathematical description of treatment processes, and others. (3 q.h.)

5750 Institutional Health - Environmental aspects of hospitals, nursing homes, penal institutions and schools. Environments are studied for biological, chemical and physical requirements. (4 q.h.)

5760 Housing Hygiene and Urban Development - Principles and practice of healthful housing including urban planning, aspects of solid and liquid waste disposal, environmental pollution, air, water, noise, and land. (3 q.h.)

5800 Environmental Radiation - Principles of ionizing radiation, interreactions with matter, and biological effects. Laboratory exercises concerning detection and measurement of ionizing radiation with emphasis on control. (4 q.h.)

5850 Insect and Vector Control - Lectures, problems and demonstrations given to the biological and physical application of modern techniques for the control of vectors. Chemical control measures including materials, formulation and safe application of insecticides, rodenticides, and fumigants. (3 q.h.)

5900-5901-5902-5903 Special Problems in Environmental Health - Independent or cooperative investigation of specific problems in Environmental Health. ((2-4 q.h.)

5910 Seminar - A study of the principles, materials and methods of research employed in Environmental Health. (1-3 q.h.)

5950 Research in Environmental Health - (3 q.h.)

Recommended and approved electives: All 5000 Environmental Health courses; 4267 Local Government Financing; 5220 Health Education; 5760 Microbiology - all subject to approval by the student's advisory committee.

INSTITUTION: FERRIS STATE COLLEGE

PROGRAM: Environmental Health Technician (A.A.S.)
Environmental Health (B.S.)

DEPARTMENT: Environmental Quality Programs

DEGREE: Associate of Applied Science (A.A.S.)
Bachelor of Science (B.S.)

CONTACT: Mr. John R. Fleming
School of Allied Health
Ferris State College
Big Rapids, Michigan 49307
(616) 796-9971

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The A.A.S. program began in 1957 and has had 332 graduates to date. The B.S. program began in 1963 and has had 403 graduates to date. The Environmental Health curriculum is designed for students who wish to prepare themselves as professional sanitarians. Emphasis is placed upon course content related to supervisory and administrative functions in environmental control.

PROGRAM REQUIREMENTS

The A.A.S. degree required six college quarters (96 quarter hours). Field training with a full-time health department is provided during the latter part of the second year. The B.S. requires 186 quarter hours. All students qualifying for the B.S. degree in Environmental Health must complete a total of at least 78 quarter hours in courses related to the fundamental of environmental health technology and practice. All students must complete the core of environmental studies comprising 37 quarter hours. Four optional B.S. programs of study are available: general environmental health, vector control, occupational health, environmental planning and management.

A program is also available that enables the individuals to complete the B.S. requirements with a minimum of required residence study. The curriculum for this option anticipates maximum utilization which have been obtained through any accredited college or university, American Council on Education approved military training, PHS-Center for Disease Control Home Study Program, or other similar training or learning experience.

CURRENT FACULTY, STUDENTS, GRADUATES

The number of instructional faculty is five. There are two special project faculty and part-time instructors and one department head. Currently there are 82 B.S. and 29 A.A.S. students who are pursuing environmental health studies (air, water, wastewater, noise, radiation, etc.). In recent years, there has been a decline in the number of A.A.S. graduates and an increase in B.S. graduates. The 1976-77 graduates number 11 for the A.A.S. and 50 for the B.S. It is estimated that 40 percent of the graduates find employment in the private sector and 60 percent in government positions.

COURSE DESCRIPTION (a partial listing)

E-H 101 Environmental Health Practices - A study of the development and organization of environmental health practices and the related public health services. Special emphasis will be placed upon the scope and fundamentals of environmental systems and their related technologies. (3 q.h.)

E-H 208 Solid Waste Management - This course is designed to study the problems and solutions to the storage, collection and disposal of solid waste. Course content includes the organization, operation and control of solid waste collection and disposal systems. (2 q.h.)

E-H 211 Water Supply and Pollution Control - A study of water management and systems of water supply and pollution control practices. Emphasis is upon water composition and quality, the development and protection of ground and surface water supplies and water treatment processes. Field trips stress the practical application of classroom lectures. (4 q.h.)

E-H 214 Vector Control - A general survey of the endoparasites and arthropods of public health importance. Emphasis is placed upon environmental and chemical control of vestors which affect man. (4 q.h.)

E-H 218 Environmental Health Laboratory - An introduction to environmental health surveillance practices utilizing the chemical and microbiological techniques of sampling, transporting, testing and interpreting test results. Emphasis will be placed upon procedures utilized for water pollution control, milk and food control, swimming pools, natural bathing areas and surface testing. (4 q.h.)

E-H 222 Environmental Health Internship - Eight weeks in on-the-job training at a county health department designated as a training center by the Michigan Department of Public Health. Students receive practical training and field experience in environmental control programs and health department-community relations. (4 q.h.)

E-H 303 Air Pollution - A comprehensive survey of community air pollution. Emphasis will be upon the air pollution problems and the strategies used for its control. The student will be taught the use of air monitoring and meteorological equipment and to effectively use the facts, ideas, or concepts, learned to interpret and solve air pollution problems. (4 q.h.)

E-H 310 Environmental Radiation - The course is designed to deal with the harmful effects of ionizing radiation. In includes procedures for radiation protection surveys, area and personnel monitoring, permissible levels of radiation in unrestricted areas and concentration in effluents. (3 q.h.)

E-H 316 Noise Control - A study of the nature of sound and its relationships to health. Emphasis is placed upon the principles and procedures employed in the measurement, evaluation and control of noise in the occupational and non-occupational environment. (3 q.h.)

E-H 405 Industrial Hygiene - A course on the problems of occupational disease hazards and measures for their prevention and control. Recognition, evaluation and control of environmental factors or stresses arising in or from the workplace are emphasized. Basic technology for assessing exposure to dusts, gases, vapors, fumes, mist and other problems related to industrial health and safety is covered. (4 q.h.)

E-H 409 Environmental Management - A study of approaches and processes essential to the management of the environment in terms of modern health concepts. Community planning practices, comprehensive health relationships and current and emerging environmental issues will be discussed. Case histories and field studies will be correlated with lectures. (4 q.h.)

EHN 211 Waterborne Disease Control - This course stresses control of waterborne diseases through water treatment and control. The transmissable diseases, the protection of water supplies, water chemistry, potable water standards, common water sources, and the sampling and testing procedures are covered. (6 q.h.)

INSTITUTION: FLORIDA INTERNATIONAL UNIVERSITY

PROGRAM: Civil Engineering Technology Option

DEPARTMENT: Engineering Technology

DEGREE: Bachelor of Science

CONTACT: Dr. Jose Villate, Coordinator
Environmental and Urban Systems
School of Technology
Florida International University
Tamiami Trail
Miami, Florida 33199
(305) 552-2824

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Since this program's inception, in 1973, it has been a part of the Division of Environmental and Urban Systems. Late in 1977, however, a decision was made that the program would be revised and merged with the Civil Engineering Technology program of the school's Construction Division. Students will earn a B.S. degree in civil engineering technology with the environmental option rather than a B.S. degree in environmental and urban systems. Officials believe that students taking the proposed curriculum will be provided a broader and more useful background. Graduates will be qualified to perform the duties of the environmental engineer or the environmental planner.

Undergraduate curriculums at the university are upper-divisional; the last two years of study are offered, and students normally transfer from community colleges after completion of the associate degree. Florida law outlines the required sequence of courses at the lower division for transfer to upper division programs.

From the time the program was developed and implemented, program officials have worked towards acquiring adequate facilities, developing a master's degree program in aquatic resources, and promoting faculty stability. Therefore, little environmental research has yet been carried out; this will become a priority in the future.

PROGRAM REQUIREMENTS

Specific entrance requirements and the curriculum format have been finalized for the revised program and a proposed curriculum has been developed. Students without the required preparatory courses may take them while completing the upper-division program by taking additional electives.

Under the Division of Environmental and Urban Systems, students were required to take forty-five quarter hours of core courses in the areas of air resources, environmental health, environmental management, transportation, urban planning, technological systems, hydraulics, water resources and aquatic systems. Additional courses for environmental systems were required in unit operations, water supply systems, computers, and engineering economy. Twenty hours of electives could be selected with an advisor.

Under the new plan, three environmental options will be available under the Civil Engineering Technology program: Environmental Systems, Planning Systems, and Transportation Systems. Students taking all three options would take the following civil engineering courses: Advanced Surveying Codes and Specifications, Strength of Materials, Materials Testing, Determinate Structural Analysis, Soil Mechanics and Foundations, Soil Mechanics Laboratory, Undeterminate Structural Analysis, Traffic and Transportation Engineering Technology, Reinforced Concrete Design, Engineering Economy, and Dynamics. Additional required courses taken would depend upon the student's concentration; these courses would be within the major field. A minimum of ninety quarter hours is required for graduation.

No special sources of financial assistance are available to students in this program. Although there is no formalized internship program, students may make appropriate arrangements and receive academic credit for related work experience under certain circumstances.

CURRENT FACULTY, STUDENTS, GRADUATES

Five faculty members teach environmental engineering technology courses full-time, and several adjunct professors from environmental agencies or industries teach courses on a part-time basis. An estimated sixty-five students are currently enrolled in the curriculum. Approximately 80 percent of these students attend school part-time while holding full-time jobs. Many already work in environmental fields.

An average of twelve persons graduates annually from this program, representing a gradual increase since the program's inception. Several graduates have continued their schooling, according to program officials, and all those seeking to find employment in the environmental field have been able to do so. An estimated 30 percent have entered the private sector, while the remainder have joined governmental agencies.

PROGRAM PROJECTIONS

Efforts will be focused upon implementing the new curriculum through the merger with the civil engineering program. Program officials foresee offering a broad technical engineering curriculum stressing long-term humanistic values. The number of students and faculty is not expected to increase appreciably, as quality will be emphasized more than quantity.

COURSE DESCRIPTION

EUS 310 Air Resources - Characteristics of the earth's atmosphere and aspects of air pollution. Classification and sources of air pollutants; effects of air pollutants on health, vegetation and property; control measures, legislation and projections. (5 q.h.)

EUS 330 Introduction to Transportation Systems - Role of transportation in urban and regional development; elements of the transportation system; characteristics and design considerations of various modes; the travel way; facilities; control and guidance; selected design standards and technology; operational characteristics; planning techniques. (5 q.h.)

EUS 340 Urban Planning Concepts - Planning fundamentals; objectives and scope of urban planning; theories of land use patterns; population studies; cohort survival techniques; employment studies; economic studies; estimating demand for various land usage; physical, social, political and managerial conditions; comprehensive plan and its elements; aesthetics and design concepts of communities; implementation tactics. (5 q.h.)

EUS 350 Applied Hydraulics - Background in basic hydraulic technology. The fundamental theorems are studies first then applied to the collection and distribution of water and to the collection and treatment of wastewaters. (5 q.h.)

EUS 352 Water Resources - Study of the hydrologic cycle; ground and surface water occurrence and quality; sanitary protection of surface and groundwater; sources of pollution; water quality management; multipurpose uses of water and reuse; determination of municipal, industrial and agricultural water requirements. (5 q.h.)

EUS 356 Aquatic Systems - Biological, chemical and physical aspects of freshwater lentic and lotic ecosystems. Emphasis is placed on the freshwater systems of South Florida. (5 q.h.)

EUS 430 Transportation Planning - Principles of transportation planning; origin-destination studies; methodology used in generating transportation plans; techniques for predicting and evaluating the consequences of various alternatives; transportation planning for the Dade County region. (5 q.h.)

EUS 445 Urban Land Use Planning - Elements of the general land use plan; location and space requirements; the use of models in planning; development of the land use plan; policy plan; implementation. (5 q.h.)

EUS 449 Planning Implementation - Planning law and administration: practice in formulation of zoning ordinance; land subdivision, urban renewal; trends and innovations in control of growth - case studies in the U.S.; critical path method; planning, programming, budgeting systems and capital improvement programs. (5 q.h.)

EUS 450 Unit Operations I - Principles of wastewater treatment. Physical and biological unit treatment operations including sludge digestion. Significance of laboratory tests. Laboratory work. Occasional field trips are required. (5 q.h.)

EUS 451 Unit Operations II - A continuation of EUS 450 incorporating chemical unit operations including effluent disinfection. Laboratory work. Occasional field trips are required. (5 q.h.)

EUS 455 Water Supply Systems - Development of water supplies; treatment of water including disinfection techniques. Distribution systems. Laboratory work. (5 q.h.)

INSTITUTION: GEORGIA INSTITUTE OF TECHNOLOGY

PROGRAM: Environmental Studies
DEPARTMENT: College of Engineering (multidisciplinary)
DEGREE: Certificate of Achievement

CONTACT: Dr. Charles R. Vail, P.E., Associate Dean
College of Engineering
Georgia Institute of Technology
225 North Avenue, N.W.
Atlanta, Georgia 30332
(404) 894-3354

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The College of Engineering offers students majoring in the standard engineering disciplines (i.e., aerospace engineering, chemical engineering, civil engineering, electrical engineering, engineering science and mechanics, industrial and systems engineering, mechanical engineering, and nuclear engineering), the opportunity to choose their electives in such a way as to permit them to qualify for receipt of a Certificate of Achievement in Environmental Studies. This option is open to master's and doctoral students only.

The multidisciplinary environmental studies program enables the graduate student to bring the expertise of his or her disciplinary major to bear on problems in the broad area of environmental engineering. Environmental Studies also provides the opportunity for a student to learn how his or her major discipline can be interrelated with other major disciplines so as to effect solutions to complex applicational problems in such areas as water quality, air pollution, marine technology, solid waste technology, radiation hazards, noise, energy usage, thermal pollution, and urban problems. A wide range of approved courses distributed through virtually all engineering and science schools of the Institute constitutes a source from which the student's advisor draws those which will constitute the multidisciplinary program of that individual student.

Students who wish to receive the certificate must fulfill all of the degree requirements of their "home" discipline in addition to meeting those for the certificate. Graduates will be able to work in the traditional occupations of their school of engineering, in addition to being fit for employment in their chosen environmental specialty area.

PROGRAM REQUIREMENTS

Full graduate level status is accorded applicants holding a bachelor's degree from an approved institution, and whose previous work has been of a nature and quality sufficient to offer reasonable assurance of success in advanced study. A conditional graduate standing will be assigned those entrants whose previous work shows deficiencies in either content or quality.

Specific graduate level certificate requirements include: a minimum of twenty-four credit hours of approved course work in a coherent package; six credit hours of approved special problem or thesis work; chosen specialty courses must relate to one's major degree atea; at least six credit hours must be outside the major field; and a grade of B or better must be earned on each course being counted toward the certificate. Certificate requirements are the same for both master's and doctoral students.

CURRENT FACULTY, STUDENTS, GRADUATES

Environmental Studies is administered by one faculty member from each of the eight cooperating departments. In addition, one faculty member each from textiles engineering, architecture, biology, chemistry and physics are involved in committee activities, in anticipation of their departments' soon offering the Environmental Studies certificate program.

Students do not declare that they are pursuing this certificate until one quarter prior to their graduation, and for this reason it is impossible to estimate how many students are involved. In 1976 four environmental studies certificates were awarded and in 1977 one was awarded, both to master's graduates, a total of five for this program.

PROGRAM PROJECTIONS

The multidisciplinary approach to a particular problem area appears to be an important development in environmental education, and in the industrial sector is causing something of a "stir". These types of programs are being expanded to create degree programs in which three or more schools of engineering would be involved in the fulfillment of degree requirements. Expansion of multidisciplinary certificate level programs will continue, as this program concept has been very well received among faculty. It is significant to note that an increasing number of requests for information on Environmental Studies has been received, and also there is an on-campus recruitment effort under way which is becoming effective, in the estimation of a program official.

COURSE DESCRIPTION (SELECTED)

A.E. 6300 Meteorology and Atmospheric Dynamics - Introduction to dynamical and physical processes of natural weather systems, hydrostatic stability and convection, radiation and heat in

A.E. 6300 (Cont'd) - atmosphere, planned and inadvertent weather modification. (3 q.h.)

A.E. 6301 Turbulence and Atmospheric Dynamics - Introduction to turbulence, turbulent transport of momentum and heat, dynamics of turbulence, boundary-free and wall-bound shear flows, statistical description and spectral dynamics of turbulence. (3 q.h.)

A.E. 6302 Air Pollution Meteorology - Fundamentals of air pollution meteorology, engineering approach to atmospheric diffusion, natural removal processes, urban and regional problems, meteroological instruments, air pollution climatology. (3 q.h.)

A.E. 6303 Atmospheric Boundary Layer - Structure and aerodynamic characteristics of atmospheric boundary layer, turbulent transport of contaminants in environment, stratified and disturbed atmospheric boundary layer, free-convection layer, current problems. (3 q.h.)

A.E. 6304 Aerospace Systems and the Environment - Effects of aerospace vehicle on environment, pollutant emissions from vehicles, chemistry and effects of emission in troposphere and stratosphere, methods of emission reduction, current problems. (3 q.h.)

A.E. 6460 Aerodynamic Noise - Jet, boundary layer, combustion, propeller and fan noise. Sonic boom, noise propagation from engines and attenuation techniques. (3 q.h.)

Chem. 5201 Analysis of Atmospheric Contaminants - Modern analytical techniques and instrumental methods of analysis including applications involving measurement of air contaminants. (3 q.h.)

C.E. 6358 Issues in Water Resources Planning and Management - Major public policy issues in water resource planning and management. Emphasis on American issues, but appropriate reference to issues in other countries. (3 q.h.)

C.E. 6363 Economics of Water Resources Development - Principles of resource allocation, benefit-cost analysis, water-resources project formulation, justification, allocation of joint costs in multipurpose developments. (2 q.h.)

C.E. 6368 Applied Environmental Resources Management - Field, laboratory and classroom studies applied to the solution of an environmental management problem under the direction of a multidisciplinary faculty team. (1 q.h.)

C.E. 6124 Air Pollution Measurements and Control - Analysis of air pollution problems of cities and industries, methods of evaluating the problems. Description, design and use of air sampling equipment. (3 q.h.)

C.E. 6128 Solid Waste Technology II - Evaluation of typical solid waste problems, application of fundamental principles to design and management, case studies of operational solid waste systems, new methods, advanced topics. (2 q.h.)

N.E. 6643 Environmental Impact of Nuclear Power Stations - Specific impact of nuclear facilities on the environment. Practical and regulatory aspects of reactor siting and the preparation of environmental impact statements. (3 q.h.)

M.E. 4327 Combustion and Flames - Stoichiometric and thermochemical analysis of fuel-oxidant reactions. Heat and mass transfer with chemical reaction applied to combustion of gas jets, solid and liquid fuels. (3 q.h.)

N.E. 6235 Nuclear Reactor Safety - Licensing procedures, sources of potential hazard, accident transients, engineered safeguards, incipient failure, diagnostic techniques and safety analysis reports are discussed. (3 q.h.)

N.E. 6251 Fundamentals of Nuclear Engineering - Reactor principles, operation, materials, control and use. (3 q.h.)

N.E. 6401 Radiological Health Physics - An evaluation of radiation protection standards, their development and enforcement. Covers topics such as effects of radiation, internal and external exposure, health physics practice and dosimetry. (3 q.h.)

INSTITUTION: HEED UNIVERSITY

PROGRAM: Ocean and Environment Affairs

DEPARTMENT: Ocean and Environment Affairs

DEGREE: Master of Arts (M.A)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Walter J. McNichols
Dean and Coordinator of Ocean and Environment Affairs
Heed University
Box 311
Hollywood, Florida 33022
(305) 925-1600

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Heed University, chartered in 1970, is a private, not-for-profit, non-sectarian institution of higher learning. It offers graduate degrees in Business, Ocean and Environment Affairs, Education and Psychology. The "University without walls" philosophy is followed, and the student body comes from all over the country, attending classes at the university several months out of each year. During the remainder of the year, students work independently, though under advisement, carrying out research, projects, and dissertation writing. The curriculum format is particularly attractive to persons who prefer to earn a degree while continuing full-time employment.

The university is licensed by the Florida State Board of Independent Colleges and Universities and has applied for accreditation with the Southern Association of Colleges and Schools. Two research grants related to ocean and environment affairs have been awarded to Heed University from the Federal Office of Sea Grant (National Oceanic and Atmospheric Administration). The university plans to develop additional research programs.

PROGRAM REQUIREMENTS

To enter a master's degree program at Heed University, a prospective student must have earned a bachelor's degree, and have had a minimum of three years of successful experience in employment. Three years of successful employment are also required to enter the Ph.D. programs, as is a master's degree or the equivalent.

Thirty-six semester credits are required for the master's degree. Of these, a maximum of six credits may be transferred from other institutions. Students carry out projects or theses for six credits each, and normally twelve credits are earned in residence. The remaining credits may be earned with additional projects, independent study, and/or with more courses or seminars in residence.

The doctoral program requires eighty credits above the master's degree. A maximum of twelve credits may be transferred and twenty-four credits must be earned in residence. Satisfactory completion of a prospectus and detailed outline of the dissertation earn ten credits, while completion of the dissertation itself also contributes ten credits. The remaining credits may be earned through independent study, projects, or additional residence work. Oral presentations and defenses of dissertations or major projects are carried out at the university during summer sessions.

Each doctoral candidate is assigned one major advisor and one minor advisor. Students in master's programs are assigned one of each. Selection of advisors is based first on discipline and second on geographic proximity to the student. Advisors help in selecting appropriate course work, and research projects, and often participate in oral proceedings.

There are no required courses, sequences, or seminars for Heed University students; much flexibility is allowed in choosing courses of study, which are tailored to meet individual career objectives. Seminars are held at the university eight weeks during the summer and one to two weeks in April and December. These seminars are interdisciplinary, and students earn three credits for each week of attendance. Many focus on research techniques, while others cover such topics as psychoanalysis and interpersonal relations. A curriculum committee meets regulary and makes program recommendations. Students, however, are given voice in seminar offerings and curriculum decision-making.

There are no predetermined requirements for obtaining a concentration in Ocean and Environment Affairs. The adequacy of a chosen course of study is determined by the university administrators and advisors. Degrees are awarded only when students have met all the requirements of the university and accrediting bodies, and all work has been of acceptable quality.

CURRENT FACULTY, STUDENTS, GRADUATES

There are approximately two hundred students enrolled in Heed University programs. Three of these are in the Ocean and Environment Affairs Ph.D. program. Ten persons to date have gained the Ph.D. with this concentration, with an average of two to three per year; there have been no students enrolled in the master's program. No graduates have sought employment in the field, as most already held jobs in some way environmentally related. Approximately 90 percent of the university's enrollment consists of out-of-state students.

Heed University has a core of faculty of about fourteen members. The large majority works with the school on a part-time basis. Numerous other persons throughout the country work with the university part-time, acting as advisors to students, and sometimes teaching seminars in residence. The adjunct faculty is a highly educated group with all having earned doctorates such as Doctor of Philosophy (Ph.D.), Doctor of Medicine (M.D.), and Doctor of Education (Ed.D.).

PROGRAM PROJECTIONS

Administrators hope to increase enrollment in the Ocean and Environment Affairs programs to forty or fifty. No curriculum changes are currently anticipated, although the curriculum committee will continually carry out internal reviews and make recommendations as deemed necessary.

COURSE DESCRIPTION

The following course listing is suggested only, and not limiting. Course credits may be earned externally on an independent study plan under faculty supervision. On-campus seminars are normally devoted to research and interdisciplinary studies. Any course may be offered on campus if a minimum of eight students register for that course.

HEA	6001	Environmental Affairs - Survey
HEA	6002	Coastal Zone - Problems
HEA	6003	Coastal Zone Management
HEA	6004	Fisheries
HEA	6005	Territorial Sea and Contiguous Zone
HEA	6006	Continental Shelf
HEA	6007	Deep Ocean - Problems
HEA	6008	Submarine Geology and Geophysics
HEA	6009	Ocean Engineering
HEA	6010	Air Pollution - Survey
HEA	6011	Water Pollution - Survey
HEA	6012	Guided Research
HEA	6013	Independent Study
HEA	6014	Governmental Aspects - Federal
HEA	6015	Governmental Aspects - State and Local
HEA	6016	Governmental Aspects - International
HEA	6017	Advanced Research
HEA	6018	Advanced Independent Study

INSTITUTION: HOCKING TECHNICAL COLLEGE

PROGRAM: Environmental Health Technology
DEPARTMENT: Natural Resources
DEGREE: Associate of Applied Science

CONTACT: Mr. David Mingus, Coordinator
Environmental Health Technology
Rt. 1
Hocking Technical College
Nelsonville, Ohio 45764
(614) 753-3591

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The first of its kind in Ohio, the Environmental Health Technology (EHT) program at Hocking Technical College trains technicians in the inspection, investigation, and reporting of environmental conditions for professional health and management personnel. In many instances, graduates also assist in the education of the community to increase its understanding of what its environmental problems are and what practical solutions are available. Though the emphasis of the program is on teaching, rather than research, basic facilities include chemistry, biology, and bacteriology labs and water-testing equipment. Students are extensively involved in field work. Faculty periodically conduct workshops on a variety of environmental topics for local sanitarians and teachers. Advisory committee members from education, health services, natural resources, and industry provide curriculum oversight.

PROGRAM REQUIREMENTS

Admission to Hocking Technical requires a high school diploma or G.E.D. certificate and an interest and attitude in the technology selected. Auults who lack a high school diploma or equivalency may receive permission to enroll if it is determined that they possess the basic ability to succeed in a technical program. Students must maintain a 2.0 overall average and a 2.0 in their major field. The basic EHT plant of study includes 106 quarter hours exclusive of an optional internship during the summer term.

CURRENT FACULTY, STUDENTS, GRADUATES

Faculty lines total 2.5 FTE in the Environmental Health program. Of the 32 first-year and 21 second-year students, approximately 15 percent are women. Though there are many veterans in the program, few students have moved from other careers to Environmental Health Technology. Recruitment efforts reach high schools across the state and focus intensively on a three-county area surrounding Nelsonville. Virtually all students are from Ohio.

On the average, the program produces 15 graduates annually. Roughly one-quarter of this number pursue additional degrees. Of those seeking employment, 85 percent are employed in their field and 15 percent in related technologies. Most students (99 percent) take jobs in the public sector. According to Hocking Technical's catalog, "the Environmental Health technician is a new job classification that provides mid-management opportunities with federal, state, and local health agencies." Other areas of opportunity are voluntary health agencies, industry with waste treatment services, and municipal water and sewage treatment plants.

Financial assistance programs available include Ohio Instructional Grants, Basic Educational Opportunity Grants, Supplemental Educational Opportunity Grants, guaranteed student loans, college work-study, Bureau of Vocational Rehabilitation monies, and scholarships. The Financial Aid Office at Hocking Technical works intensively to insure that any students who need monetary help to attend school receive it.

PROGRAM PROJECTIONS

Long-range goals of the Environmental Health Technology program are to expand the curriculum in the areas of wastewater treatment, pesticide licensing, grantsmanship, and National Food Service Industry (NFSI) certification. The school would also like to participate in the continuing environmental health training now required by Ohio law for sanitarians (3-6 hrs./year). Three grant proposals have been submitted to the Department of Health, Education, and Welfare for carbon monoxide training programs. The staff would like to set up training workshops and courses for area teachers; but because Hocking Technical is not a post-baccalaureate institution, this opportunity does not exist. The future of the Environmental Health Technology program, nevertheless, is bright, according to its staff personnel.

COURSE DESCRIPTION*

1831 Community Health Administration - A study of the history, the areas of responsibility now covered by public health agencies, various volunteer health services, and new public health areas. (3 q.h.)

1850 Public Health Law - A survey of the Ohio Revised Code and the Ohio Sanitation Code using case studies and related experiences to illustrate the relationship of public health problems and their legal problems.

1806 Environmental Health I - A survey of basic principles in water contact, air contact, and solid waste problems. The course includes field trips to see both good and bad practices of various community health services. (5 q.h.)

1870 Occupational Safety - A study of Ohio safety codes and accepted safety practices and procedures pertaining to employees and employers. (3 q.h.)

1880 Seminar - A series of lectures by public health officials covering duties, responsibilities, and manpower needs of their agencies. Public health control measures as applied by selected voluntary health agencies are also discussed. (3 q.h.)

1816 Food Protection - An in-depth study of food protection including local, state, and federal regulations concerning food protection, processing, and service operations. Epidemiological procedures in the collection and assimilation of data in food poisoning outbreaks are studied. (5 q.h.)

1385 Agronomy - An introductory course in soil science covering basic concepts of soil formation, the relationships between soil and vegetation types, composition, and basic conservation practices. The majority of the field work deals with soil sampling and soil testing. (3 q.h.)

1821 Environmental Engineering I - Air, water, and solid waste pollution problems and their causes, effects, and prevention are studied. Labs include practical application of air, water, and solid waste management, inspection, and control. (5 q.h.)

3203 Individual Studies in Environmental Health - By arrangement. (1-5 q.h.)

1891 Internship - On-the-job training in the environmental health field through special arrangement with an instructor of environmental health. (12 q.h.)

1810 Environmental Problems - An independent study in which the student chooses a specific area of the environment on which to do field work and/or text research and submit a term paper on that subject. (2 q.h.)

0354 Entomology - An introduction to the study of insects. Anatomy and major orders of insects are discussed in lecture sessions. Field collection and identification of insects collected are covered in laboratory sessions. (2 q.h.)

2836 Water Sewage and Wastewater Problems - A comprehensive study of regulations and standards of shelter, space, individual home sewage development and development of home water supplies. (5 q.h.)

1805 Ecology - A study of the effects of human population on national resources. (4 q.h.)

2840 Bacteriology - A study of the principles of bacteriology. Lab procedures provide experience in collection, isolation, culturing, staining, and identification of various microorganisms. (4 q.h.)

2837 Vector Control - A study of commonly encountered pests and their eradication. Various types of rodents, insects, and other pests such as pigeons are identified. Emphasis is on methods of control and the safety precautions necessary when handling various chemicals and infected vectors. (5 q.h.)

2851 Epidemiology - A study of communicable human diseases with emphasis on identification, frequency, distribution, control, and prevention of diseases endemic to this geographic area. (4 q.h.)

2861 Sanitation Lab Procedures - A review of methods of sample collection, specimen preservation, and laboratory procedures necessary to achieve accurate results. (3 q.h.)

2856 Public Area Sanitation - A study of public institutions such as camps, swimming pools, schools, and mobile home parks from the standpoints of design, construction maintenance, and sanitation. (5 q.h.)

*Courses listed in the sequence taken by a student.

INSTITUTION: HOWARD UNIVERSITY

PROGRAM: Environmental Engineering
DEPARTMENT: Civil Engineering
DEGREE: Master of Engineering

CONTACT:
Professor James Johnson
Department of Civil Engineering
School of Engineering
Howard University
Washington, D.C. 20059
(202) 636-6565

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Engineering program, accredited by the ECPD, was organized in 1969. It is structured so that each program of study is best suited to the student's special interests. A balance between theory and practice is achieved through course and laboratory work. Laboratory facilities include two sampling stations, mobile source Pollution Monitoring Laboratory, and well-equipped Structures and Soils Mechanics Laboratories.

The program is structured so that students are prepared for work in governmental areas and for work with consulting firms. Instruction covers a wide spectrum of topics, including water chemistry, water and wastewater treatment, air resources, air pollution control and radiological health.

PROGRAM REQUIREMENTS

The Environmental Engineering program admits students with engineering or environmentally related degrees,e.g., science backgrounds. They must have maintained a 3.00 grade point average in undergraduate studies and have proved they are capable of the work required at the graduate level.

Once admitted, the student must complete a minimum of thirty credits, of which at least twenty must be in his/her major area. The thirty credits may be comprised of course work only, or including up to six credits of thesis work. Non-thesis students must include at least one project type course in their program. If no thesis is written, a written comprehensive examination must be taken. If a thesis is written, a final oral examination on the thesis submitted. There is no foreign language requirement unless the student is research oriented or intends to pursue further study.

Students receive financial support from various sources. These include graduate assistantships doing outside research, fellowships from the University, work study programs where the student works for companies outisde the University (only one or two students receive this form of aid), and research assistantships totalling up to five thousand dollars annually.

CURRENT FACULTY, STUDENTS, GRADUATES

There are currently four full-time faculty members on the teaching staff and one faculty member doing research. Research funding is available from a contract with American Can, O-Brien& Gere, and two contracts with Water Resources Institute. The department feels a strong need for more funding for basic research, and feels it might come from industrial sources.

Students are recruited through referrals from other students and schools, and publications. Twenty full-time and four part-time students are currently enrolled in the program. An average of ten students graduate annually. Through personal contact with the graduates, it is found that approximately ten percent go on to further schooling, fifty percent find employment in their field, and thirty-five percent find employment in related fields. Of those employed, half work for the government and half work for private agencies. The graduates are placed through the University placement office, considered the most effective means, and through referrals from faculty members in the Department, not quite as effective.

PROGRAM PROJECTIONS

The Environmental Engineering program plans to introduce a Ph.D. program in the near future. With the introduction of the program, it would be necessary to acquire one more staff member. The program also plans to introduce new workshops and seminars to the present curriculum and would like to introduce other courses applying physical and biological sciences to environmental problems. To implement the curriculum will take approximately six months, and the department will need more funding, in order to implement it fully.

COURSE DESCRIPTION

(the following is a partial listing of courses)

234-501 Water Treatment & Water Resources - Water resource systems planning in relation to demographics, chemicals, and biological factors. (3 s.h.)

234-502 Wastewater Treatment - Establishment of water quality control standards: analysis and adjustment of various wastewaters; design and specification of treatment units. (3 s.h.)

234-511 Chemistry of Water & Wastewater - Physical and chemical properties of water and wastewater. Kinetics equilibria in water and sewage, organic and inorganic constituents of water and its effect on man's environment. (3 s.h.)

234-516 Properties of Air Pollutants - Physical, chemical, geological, and social behavioral properties of dusts, droplets, and gases in the atmosphere. Air pollutant sampling and analysis. The planning and operation of air pollution surveys. (3 s.h.)

234-541 Radiological Health - The atomic nucleus, the radius of the nucleus, mass of nuclei and meutral atoms. Radioactive decay, alpha and gamma, beta, internal conversion and electron capture, spontaneous fission. Decay equations, equilibrium and induced activity. Photon interactions with matter, compton scattering and absorption, photoelectric effect, pair production, attenuation, absorption and energy transfer. (3 s.h.)

234-550 Water Quality Management - Mechanics and kinetics of stream and estuary pollution. Effects of natural processes and pollution by man. Types of pollutants: temperature, inorganic salts oxygen demanding contaminants, sediments, organic compounds, and nuclear wastes. Self-purification. (3 s.h.)

234-565 Air Pollution Control Standards - Mechanics and kinetics of stream and estuary pollution. Effects of natural processes and pollution by man. Types of pollutants: temperature, inorganic salts, oxygen demanding contaminants, sediments, organic compounds, and nuclear wastes. Self-purification. (3 s.h.)

234-566 Solid Waste Disposal - Study of traditional patterns and problems of solid waste storage, transport, and disposal. Examination of various engineering alternatives with apporpriate consideration for air pollution control, water pollution control, and land reclamation. Analytical approaches to recovery and reuse of materials. (3 s.h.)

234-601 Industrial Wastewater Management - Waste disposal problems of various industries, causing pollution of natural bodies of water, method of treatment, and administrative and regulatory aspects are discussed, with emphasis on biochemical treatment processes. (3 s.h.)

234-608 Advanced Water Treatment & Resources - Analysis of water resources systems, regulation of quantity and quality, water laws and conflicts of objectives. Planning, design and management of water resources systems, modern methods of water treatment. (3 s.h.)

234-609 Environmental Toxicology - Introduction to the mechanisms and impact caused by toxic gases, atmospheric particulate matter, and chemicals in wastewater on biological systems. Experimental models for testing toxicity, mutagenicity, carcinogenicity, and teratogenicity in mammals will be discussed. (3 s.h.)

INSTITUTION: HUNTER COLLEGE

PROGRAM: Environmental Health Science

DEPARTMENT: School of Health Sciences

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)

CONTACT: Dr. George J. Kupchik
Program Director, Environmental Health Science
School of Helath Sciences
Hunter College
105 East 106th Street
New York, New York 10029
(212) 860-1251

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental Health Science is a program designed to develop liberally educated health professionals and offers a curriculum requiring humanities, basic sciences, and social sciences, as well as professional studies in environmental health sciences. The graduate program originated in 1970 and the undergraduate program began in 1973.

The B.S. program is junior and senior level and students take their first two years of liberal arts courses at Hunter or another college or university and apply for entrance to the School of Health Sciences in their junior year. This program also has a cooperative education program with the Occupational Safety and Health Administration in which students can alternate between courses and professional work experience. The Master's program offers three concentrations but the student need not specialize. The concentrations are environmental assessment and control, biological response to environmental stress, and environmental health planning and administration.

Laboratory facilities of the School of Health Sciences are available for use by program faculty and students. A computer center is also located within the School.

PROGRAM REQUIREMENTS

Admission to the B.S. program requires the completion of the first two years of a college program with a cumulative index of 2.5 or above and including eight credits of college biology, chemistry, or physics.

The M.S. program generally requires an undergraduate major in science or engineering for admission. Students are expected to have completed a minimum of two years of chemistry, one year of biological sciences, one year of physics, and one semester of college mathematics. The aptitude section of the Graduate Record Exam is also required.

A B.S. degree in Evnironmental Health Science requires a total of one hundred and twenty-eight credits which includes a minimum of forty-five credits in environmental health science courses, thrity-six credits in basic sciences and math, and thirty-four credits in humanities, social sciences and English.

Requirements for the Master's degree includes a minimum of thirty-six credits, including eleven credits in core courses and approximately sixteen to eighteen credits in one of the concentrations: environmental assessment and control, radiological health engineering, or environmental health planning and administration. Also required are a Master's thesis and four to eight credits in field work or laboratory research projects, and a two credit thesis seminar.

CURRENT FACULTY, STUDENTS, GRADUATES

Program faculty consists of three full-time members and four adjunct members each semester. Other faculty of the School of Health Sciences are involved in the program from time to time. Most faculty time is devoted to teaching. Research funding presently consists of one grant from EPA.

There are presently thirty-four undergraduates in the program, all full-time and twenty full-time and thirty-two part-time students in the graduate program. Many students have transferred to the program from other curriculums, particularly biology. General means of recruitment of students for the program has been through newspaper advertising and sending information to other schools. Several students are receiving financial assistance, primarily from Public Health Service training grants. One student is currently receiving a research assistantship.

The B.S. program graduates approximately ten students per year and is steadily increasing. An average of twelve students graduate from the M.S. program each year and this figure is expected to remain stable. Graduates almost always find employment in their field, most with government agencies, but also in private industry, consulting firms, and teaching. Placement of graduates is normally done through informal contacts of the faculty.

PROGRAM PROJECTIONS

Program officials anticipate the development of a concentration in occupational health at the graduate level and additional courses at the undergraduate level. This would consist of several courses and would require at least one additional faculty member. Preliminary approval has already been obtained for two of the proposed new courses.

COURSE DESCRIPTION

(the following is a partial listing of courses)

Undergraduate courses:

38 300 Environmental Measurements Laboratory - Most frequently employed methods of sampling and analysis of environmental media. (3 s.h.)

38 310 Principles of Water Quality Management - Lectures and seminar discussions are designed to develop a basic understanding of the importance of water resources, past development of the field, its current status, and trends for the future. Many current topics including stream pollution, quality requirements, and treatment systems. (3 s.h.)

33 312 Air Pollution Control - Sources, transport phenomena, health effects, and other biological effects and non-biological effects of community air pollutants are studied. (3 s.h.)

33 315 Solid Waste Management - The management, handling and disposal of solid waste from the community, industry and institutions; systems of sanitary landfills, incineration, recycling, and conversion. The public health significance of solid waste management. (3 s.h.)

33 318 Fundamentals of Vector Control - The public health significance of insects and rodents, life cycles, identification, disease transmission, methods of control and the use of insecticidal and rodental agents. (2 s.h.)

33 322 Radiological Health - The physics of ionizing radiations, their interaction with matter, and their effects are discussed. (2 s.h.)

Graduate courses:

IHE 700 Environmental Health and Safety - Chemical, physical, and biological factors influencing the quality of the domestic and industrial environment; air and water pollution; and other topics. (3 s.h.)

IHE 740 Application of Computers to Environmental Problems - Consideration of basic concepts and principles of computers and programming as they are currently employed in the solution of environmental problems. (3 s.h.)

IHE 741 Environmental Monitoring and Direct Instrumental Methods - Quality control monitoring for potentially dangerous constituents on a semi-continuous or continuous basis. Factors influencing reliability of sampling procedures. Instrumental methods for SO_2, NO_2, CO, toxic metals and dust, pesticides, noise. (4 s.h.)

IHE 750 Environmental Physiology - Man's physiological responses to environmental stress factors, e.g., heat and cold, air pollutants, noise, etc. (2 s.h.)

IHE 751 Microbiology: Applications to Environmental Health Problems - A study of environmental microbiology, such as microbiology of food and dairy products, water, sewage, air, etc., using standard and recommended procedures for environmental samples. (3 s.h.)

IHE 754 Environmental and Occupational Toxicology - Toxic chemicals occurring in domestic and occupational environments: aspects of entry to the body, mode of action, metabolism and excretion. Emphasis on in vivo interactions between various toxic chemicals leading to potentiation or antagonism. Laboratory portion of the course includes the methodology of toxicity testing including determination of LD50 on small animals by oral, inhalation and dermal administration; other topics. (4 s.h.)

IHS 744 Industrial and Environmental Noise Problems - Evaluation and control of noise hazards; effects of noise on man; medical-legal aspects of noise-induced hearing impairment. (3 s.h.)

CHE 620 Chemistry of Environmental Pollution - The pollution of the environment classified by its three principal sources, industrial, domestic and agricultural activities discussed in terms of the reaction and physical chemistry of the agents therein produced. (2 s.h.)

URB 708 Environmental Planning - Current and emerging issues in controlling and preventing environmental degradation through air and water pollution, solid wastes, noise, pesticides, radiation, etc. These subjects to be viewed in relation to population growth and trends in energy conversion, materials processing and the recycling of residuals. (3 s.h.)

IHE 720 Environmental Criteria and Standards - An analysis of selected criteria and standards for environmental protection to determine their origin, validity, and feasibility. Students, with faculty guidance, will prepare review documents on specific standards documenting the standard, applicable criteria and assess supporting published data. The review will also evaluate the feasibility and implications for enforcement. (3 s.h.)

INSTITUTION: JOHNS HOPKINS UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Department of Geography and Environmental Engineering

DEGREE: Master of Science in Engineering (M.S.E.)
Master of Arts (M.A.)
Master's Program in Systems Analysis and Economics for Public Decision Making
Doctor of Philosophy (Ph.D.)

CONTACT:
Dr. Gordon Wolman
Chairman, Dept. of Geography and Environmental Engineering
Johns Hopkins University
Baltimore, Maryland 21218
(301) 338-7092

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Interdisciplinary in structure, the Department of Geography and Environmental Engineering has four different areas of strength. These are: Environmental Engineering; Ecology, Environmental Science, and Surficial Earth Processes; Systems Analysis and Economics for Public Decision Making; and Urban Studies and Spatial Location.

The Environmental Engineering program is concerned with measures to control environmental pollution, to contribute to environmental management, and to protect the public health. The program's aim is to develop the student's understanding of: waste materials contributing to pollution, technology associated with treatment of such wastes, and observation and measurement of the effects of waste on the water environment. The second area, Environmental Science, is based upon the premise that environmental scientists should have knowledge of chemical and biological principles and their interrelationships. Study and research is made available in the areas of aquatic biology, water and atmospheric chemistry, surficial earth processes, biogeography and soil science. The third area is intended to give students skills required today for analysis of public decisjon making problems, and the final area, Urban Studies and Spatial Location, involves the study of basic social and economic factors influencing regional form.

The department stresses individuality in selecting courses which pertain to the student's special field of interest. Once the fundamentals of the field are mastered, the student has complete freedom to pursue studies in related fields. Independent studies, seminars, workshops and laboratories comprise a vital part of the student's program.

PROGRAM REQUIREMENTS

Students having a sound background in natural, social or engineering sciences with a bachelor's degree in science, arts, engineering, or the equivalent, are admitted to the program. Except for the master's program in Systems Analysis and Economics for Public Decision Making, the master's and doctorate degree programs are not rigidly structured. The Master of Science in Engineering and Master of Arts degrees require one year of formal course work with no more than three quarters in the Department of Geography and Environmental Engineering. Those in the M.A. program and those planning to go onto the doctorate program must acquire reading knowledge of one foreign language. Candidates for these degrees must conduct an independent investigation, submitted in essay form.

Candidates for the master's in Systems Analysis and Economics for Public Decision Making program must take two semesters of full-time course work plus one summer for a master's essay approved by the department. Student's may choose one of two specialty areas emphasizing either systems analysis or economics. The following required courses apply to both areas: Mathematical, and Economic Foundations for Public Decision Making, and Environmental Policy Analysis.

The Ph.D. program requires two full academic years of formal course and seminar work and a minimum of two consecutive semesters as a full-time resident student. Students must be involved in teaching activity in the department for one course equivalent and must acquire reading knowledge in one foreign language of scientific significance. One academic year prior to graduation, students usually take the Graduate Board Oral Examination.

Students receive financial assistance through university fellowships, tuition grants, university assistantships, work study, and research assistantships. The department receives grants from the Ford Foundation, federal, state and local agencies in the environmental field, and private sources. It also receives support from the university, the National Science Foundation, and the National Defense Education Act.

CURRENT FACULTY, STUDENTS, GRADUATES

There are currently eleven full-time faculty members, all devoting time to teaching and research. There is also one part-time lecturer. Research currently being conducted includes an EPA project, a 208 project, and a project for the City of Baltimore.

Thirty-four full-time and four part-time males are enrolled in the program, and nine full-time and three part-time females are currently enrolled.

There are an estimated six to eight graduates each year, but this number fluctuates significantly. Through personal contact, the program finds that only a small fraction of graduates of the master's program go on to further schooling. Of the remaining, 50 percent go into teaching and/or research in engineering, arts and sciences; 40 percent go into technical, administrative and regulatory employment at the federal, state and local level; and 10 percent go into consulting. All of those employed work in their field of preparation.

PROGRAM PROJECTIONS

The department plans to increase the staff by two, in the area of Environmental Engineering over the next five years. The program is trying to restore the balance between the engineering, arts, and sciences sectors of the program. There is no plan to develop new programs, as the demand for graduates of the present program is very high.

The program plans to continue and stress its interdisciplinary structure, though it feels that this structure is not necessarily appropriate for all institutions.

COURSE DESCRIPTION (SELECTED)

38.30 Introduction to Environmental Engineering - The course includes water supply, waste-water treatment, water quality, atmospheric pollution and pollution control, and solid-waste management. (3 s.h.)

38.301 Water and Wastewater - A study of population growth and distribution; water supply requirements and domestic sewage flows; techniques for analyzing rainfall, runoff, fluid flow, reservoir silting and groundwater data; and the application of these techniques to the design of sanitary works. (3 s.h.)

38.302 Water and Waste Treatment - The theory and practice of water purification and waste water treatment, including aeration, chemical coagulation, sedimentation, thickening filtration, biological waste treatment, chlorination, water softening, removal of iron and manganese, solids treatment and disposal and nutrient removal. The influence of stream pollution on the degree of waste treatment required, and criteria for preservation of water quality for various uses are discussed. (3 s.h.)

38.306 The Biology and Ecology of Polluted Waters - This course is intended to provide students with an insight into the biological and responses to polluted waters. (3 s.h.)

38.353 Principles of Hydrology - Examination of the various components of the hydrologic cycle including precipitation, infiltration, runoff, subsurface flow, and evaporation. (3 s.h.)

38.665-666 Seminar in Water Science and Management - These seminars have as their objective the presentation and discussion of the problems associated with the management of water for all purposes, with emphasis on modification or innovations in concepts of use, economic values, administrative controls and political organizational arrangements, as well as presentation of existing and emerging problems of a technical and scientific nature requiring further study and research. (2 s.h.)

38.7 Issues in Environment - Presentation of critical environmental issues by university faculty and others followed by class discussions of the problems and issues.

38.329 The Chemistry and Physics of Water Pollution - A discussion, based on concepts from the natural sciences, of the chemical and physical processes associated with changes of the quality of natural water systems caused by addition of pollutants. (3 s.h.)

38.330 The Chemistry and Physics of Air Pollution - A discussion based on concepts from the natural sciences, of the chemical and physical processes associated with changes in atmospheric quality caused by additions by pollutants. (3 s.h.)

38.366 Physiological Ecology - The physiological response of whole organisms to environmental stresses and the ecological implications of such responses. (3 s.h.)

38.341 Principles of Human Geography - Spatial aspects of human organization with emphasis upon the principles of location theory and their application to social and cultural phenomena. (3 s.h.)

38.619 Urbanization and Environmental Quality - This course will explore the relationships between growth, urbanization and environmental quality. (3 s.h.)

38.358 Resource Management and Conservation - A theoretical and empirical analysis of the economic concepts pertaining to the development, use, and conservation of natural resources. (3 s.h.)

38.359 Environmental Policy Analysis - This course focuses on current issues of environmental management, but in so doing explores the problems of making choices about environmental quality and the management of common property resources in the American economic and political system. (3 s.h.)

38.603 Water Resources Systems Engineering - This course will consider descriptive and optimization-oriented water quantity models. Topics include simulation of reservoir operation; optimal operation and sizing of reservoirs in series and parallel; and many others. (3 s.h.)

INSTITUTION: KANSAS STATE UNIVERSITY (KSU)

PROGRAM: Chemical Engineering

DEPARTMENT: Chemical Engineering

DEGREE: Bachelor of Science in Chemical Engineering (B.S.)
Master of Science in Chemical Engineering (M.S.)
Doctorate in Chemical Engineering (Ph.D.)

CONTACT: Dr. L. T. Fan, Head
Department of Chemical Engineering
Kansas State University
Durland Hall
Manhattan, Kansas 66506

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Chemical Engineering at Kansas State University awards three major degrees--B.S., M.S., and Ph.D. The curriculum offers a broad, fundamental background in chemical engineering science and application to undergraduates, who can also emphasize areas such as chemistry, mathematics, material science, management, computer science, and bioengineering. Graduate students pursue research interests utilizing well-equipped laboratories in transport phenomena, reaction engineering, thermodynamics, biochemical and biomedical engineering, process dynamics and control, and food engineering. The department has shop facilities in which unusual equipment is built and repaired, and the College of Engineering and university computer centers are used extensively.

Research support has come from the National Science Foundation, U.S. Department of Agriculture, U.S. Air Force, Energy Research and Development Administration (now Department of Energy), Environmental Protection Agency, National Institute of Health, and the university's Engineering Experiment Station as well as private sources. The faculty publish actively, and the department is currently engaged in cooperative research projects with Yamanashi University (Japan) and the U.S.S.R.

PROGRAM REQUIREMENTS

Undergraduates must complete 134 semester hours for graduation with a B.S. in Chemical Engineering. Admission to the KSU Graduate School in full-standing requires that the applicant have 1) a bachelor's degree from an approved institution, 2) adequate undergraduate preparation in the proposed major field or equivalent evidence of an advanced background for undertaking an advanced degree program, and 3) an undergraduate average of B or better in the junior and senior years.

CURRENT FACULTY, STUDENTS, GRADUATES

Of the eleven staff members in the department, ten occupy teaching positions though all devote some time to research (30-40 percent); one person is a full-time researcher. Faculty salaries are supplemented by outside sources during the summer months (grants, appointments in other departments). Of the ten Ph.D. and twelve M.S. students, approximately 90 percent are male. Numbers of graduates annually remain stable (two Ph.D., four M.S.); and although KSU's enrollment is increasing rapidly, the Chemical Engineering Department does not seek to expand drastically and beyond its capacity.

Graduates are traced annually through a departmental newsletter, and computerized lists (by employer and location) are maintained. During their careers, chemical engineers can expect to participate in many decisions crucial to the preservation and improvement of society, especially in the areas of energy and food production, resource management, and the specification and design of pollution control processes. Employment opportunities exist in the chemical, petroleum, pharmaceutical, plastics, paper, and food processing industries, as well as government service. Virtually all students completing degrees in this program are employed as chemical engineers (60 percent in the private sector, 10 percent in government, 20% in teaching).

Following a "no assist, no admit" policy at the graduate level, all M.S. and Ph.D. students are supported by state monies or grants ($400-500/mo).

PROGRAM PROJECTIONS

Due to student enrollment growth in the past several years, the Department of Chemical Engineering expects to add one or two general curriculum faculty members in the next two years. No major curriculum developments are projected, in part because the existing course structure is flexible enough to adapt to new techniques in chemistry when they are developed. Students are given basic principles and technological skills which are generally useful even as the profession changes.

COURSE DESCRIPTION

Undergraduate and Graduate courses in minor field:

520 531 Transport Phenomena I - A unified treatment of the basic principles of momentum, energy and mass transport. (3 s.h.)

520 531 Transport Phenomena II - Continuation of Transport Phenomena I with special emphasis on mass transfer. (3 s.h.)

520 550 Chemical Reaction Engineering - Applied chemical kinetics and catalysis including the analysis and design of tubular, packed bed, stirred tank and fluidized bed chemical reactors. (3 s.h.

520 561 Chemical Process Dynamics & Control - A study of the unsteady state behavior of chemical processes, modeling and simulation of chemical processes, classical control theory and design. (3 s.h.)

520 570 Ch.E. Systems Design I - Basic Concepts of optimization and process economics with application to the design of chemical processes. (3 s.h.)

520 571 Ch.E. Systems Design II - The synthesis and design of chemical processing systems. Emphasis will be placed on the solution of comprehensive systems design problems. (3 s.h.)

Undergraduate and graduate courses:

520 715 Biochemical Engineering - The analysis and design of biochemical processing systems with emphasis on fermentation kinetics, continuous fermentations, aeration, agitation, scale up, sterilization, and control. (3 s.h.)

520 725 Biotransport Phenomena - Principles of transport phenomena applied to biological and physiological processes. Membrane transport processes, circulatory system transport phenomena, transport and distribution of drugs. (3 s.h.)

520 805 Selected Topics in Biochemical Engineering - Subjects of current interest in the broadest sense of biochemical engineering. These involve not only chemical engineering problems which contain biochemical, biological or medical elements but also application of chemical engineering principles and methodologies to biochemical, biological, medical and ecological problems. (3 s.h.)

Graduate courses:

520 822 Advanced Chemical Reaction Engineering - Theory of kinetics and catalysis in homogeneous and heterogeneous systems, with application in chemical reactor design and process development. (3 s.h.)

520 826 Advanced study of mass transfer operations. (3 s.h.)

520 850 Advanced Chemical Process Dynamics - The dynamical behavior of chemical reaction systems and process equipment used in chemical plants. Control mechanisms for these systems. (3 s.h.)

520 862 Advanced Transport Phenomena I - Advanced treatment of momentum, energy and mass transport, with emphasis on momentum transport in chemical engineering applications. (3 s.h.)

520 867 Advanced Transport Phenomena II - Advanced treatment of momentum, energy and mass transport, with emphasis on energy and mass transport in chemical engineering applications. (3 s.h.)

520 871 Advanced Process Design and Optimization - Advanced problems in the optimal design and economic evaluation of plant equipment and processes for the chemical and allied industries. (3 s.h.)

520 910 Selected Topics in Transport Phenomena - Subjects of current interest such as surface phenomena, turbulent transport, droplet mechanics, multi-component systems. (3 s.h.)

520 915 Selected Topics in Process Dynamics - Study of the most recent methods for analysis of the dynamic behavior and control of complex systems and industrial processes. The use of Lyupanov theorems and the maximum principle are examples of the methods to be studied. (3 s.h.)

520 920 Selected Topics in Unit Operations - Study of topics as zone melting, foam fractionation, membrane permeation, thermal diffusion, and unsteady state operations. (3 s.h.)

520 925 Selected Topics in Process Design and Optimization - Study of advanced methods of process design and optimization, such as modern variational methods and dynamic programming. Applications to be chosen mainly from the chemical and allied industries to include stochastic as well as deterministic problems. (3 s.h.)

INSTITUTION: KANSAS STATE UNIVERSITY (KSU)

PROGRAM: Institute of Environmental Research

DEPARTMENT:

DEGREE: None awarded

CONTACT: Dr. Frederick H. Rohles, Director
Institute for Environmental Research
Kansas State University
Manhattan, Kansas 66506
(913) 532-5620

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

With the donation of the Environmental Chamber from the American Society of Heating, Refrigerating, and Air conditioning Engineering (ASHRAE) which was located in Cleveland, Ohio, and the completion of facilities to house this valuable equipment, the Institute for Environmental Research was dedicated in 1963. Initially, the major research thrust at the Institute was in the area of thermal comfort. Since then, however, the purposes have expanded and can be summarized as follows: (1) to study the effects of altered environments on physiology, health, comfort, learned and innate behavior, and affectivity and comfort; (2) to conduct air pollution and fine particle research relative to health and comfort; (3) to conduct research in bio-medical engineering; and (4) to provide the staff and facilities for graduate training in bio-environmental engineering.

Institute facilities and staff are used for university-wide research programs, graduate student thesis research, and private and governmental programs sponsored by agencies. Areas of research expertise include all aspects related to the interaction of man and his thermal environment (thermal comfort, humidification, air movement, clothing, physical activity, heat stress, and personal protection; fine particle technology, particularly that related to air contamination and air pollution control; modeling; foods and nutrition; comfort in the elderly; health in school children; energy conservation; and environmental requirements for laboratory animals.

Institute personnel maintain that research must be application of science and concentrated on human factors. Centered around the concerns regarding our energy use and conservation practices, the Institute cooperates with manufacturers of outdoor and wilderness materials to evaluate the durability and utility of their products under stressful conditions. Major research funding has also come from Ford Motor Company, ASHRAE, National Institute of Health (National Institute of Occupational Safety and Health), 3M Center, U.S. Air Force, The Northface, Coleman Company, Biolet and the university's Engineering Experiment Station.

The Environmental Chamber--one of three in the world--measures 12' x 24' with an adjustable ceiling of eight to eleven feet. Studies of air temperature and mean radiant temperature can be investigated independently, and complete instrumentation measures surface and air temperatures and automatically controls all room variables. In addition to the chamber, KSU has four walk-in climatic control rooms and an isolation facility providing temperature, humidity, sound, and light control capabilities; several Digitec Automatic Data Acquisition Systems, a Brookline Metabolic Scale, Collin Treadmill, Physiologic Monitoring equipment, an electrically heated copper manikin (only non-government one owned), and a guarded hot-cold plate built by KSU as specified by the American Society of Testing Laboratories to assess heat transfers of materials (insulation, carpets). In the Fine Particle-Air Pollution Laboratory, equipment includes a 40-foot wind tunnel, 10' x 12' test kitchen for range hood testing, and a vacuum cleaner test area.

PROGRAM REQUIREMENTS

(not applicable)

CURRENT FACULTY, STUDENTS, GRADUATES

Since its inception in 1963, over thirty-five faculty members from various KSU departments have utilized the Institute facilities. The director of the Institute serves as its sole full-time staff member with 70 percent of his time devoted to research and 30 percent devoted to teaching. At any one time, approximately ten students are engaged in research projects (75 percent undergraduates) independently or with faculty members; these students may receive some financial renumeration from available grant monies.

PROGRAM PROJECTIONS

Though KSU's Institute for Environmental Research provides an excellent interdisciplinary training ground for students interested in research and opportunities for sophisticated study by faculty members on man's internal environmental system, continued financial support is critical if the program is to expand. Already the decline in available monies has necessitated a decline in research activity at the Institute.

INSTITUTION: KANSAS STATE UNIVERSITY (KSU)

PROGRAM: Mechanical Engineering

DEPARTMENT: Mechanical Engineering

DEGREE: Bachelor of Science in Mechanical Engineering (B.S.)
Master of Science in Mechanical Engineering (M.S.)
Doctorate in Mechanical Engineering (Ph.D.)

CONTACT: Dr. Paul L. Miller, Head
Department of Mechanical Engineering
Kansas State University
E108 Seaton Hall
Manhattan, Kansas 66506
(913) 532-5610

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Kansas State University's Department of Mechanical Engineering offers undergraduate and graduate degrees in a program emphasizing technical expertise in a wide range of environmental areas. According to a recent catalogue, graduates work in pollution control, computers, food supply and processing, communication systems, power generation and distribution, petroleum location and production, aircraft, environmental control, transportation, construction, atomic energy, etc.

The curriculum is designed to prepare students for this broad occupational range. Undergraduates take engineering science courses in the sophomore and junior years and engineering application courses in the junior and senior years. Laboratory, humanistic, and social science courses complement the engineering core. The B.S. sequence culminates in a senior design laboratory where teams of three to five students each work on an authentic engineering problem supplied by an industrial sponsor. Considerations of cost, social impact, economics, product life, and the like are usually involved, as well as the technical solution of the problem. At the end of the project, a written report is prepared and a verbal presentation made to engineers and officials of the sponsoring company. Frequently a working model is fabricated and demonstrated.

Students pursuing graduate study can elect advanced work and research in the following areas: heat transfer, thermodynamics, air conditioning, energy conversion, automatic control, fluid/gas dynamics, aerodynamics, environmental engineering, biomedical engineering, propulsion systems, engineering design, kinematics and vibrations.

The Department of Mechanical Engineering boasts of separate well-equipped laboratories in air diffusion, fluid controls, fine particle technology, instrumentation, thermal sciences, and vibrations. Graduate students also have access to the university digital and analog computers and the various engineering laboratories and shops.

In the past two years, the Department of Mechanical Engineering has experienced a ten-fold increase in research funding received. In addition to some miscellaneous sources, monies have been received from the National Science Foundation; National Bureau of Standards; American Society of Heating, Refrigerating, and Air Conditioning Engineers; 3M Center; National Institute of Health; the university's Engineering Experiment Station; and Christiansen Diamond Products Company. Research grants in force in July, 1977, were for $236,000.

PROGRAM REQUIREMENTS

Residents of Kansas who graduate from an accredited Kansas high school are admitted to Kansas State University. Out-of-state applicants are expected to have a strong academic rank in class and to have made good scores on the American College Test battery.

To complete Kansas State's undergraduate program in Mechanical Engineering, a student must take 133 semester hours (see program structure). Students enrolling in an M.S. or Ph.D. program who have received the B.S. or M.S. degree in Mechanical Engineering from a school which does not have an Engineers' Council for Professional Development accredited curriculum in Mechanical Engineering are required to take a qualifying examination in several major areas (thermodynamics, differential equations, dynamics, and heat transfer) or in lieu of the examination, take the appropriate undergraduate course for credit.

The M.S. degree candidate may choose from three options: 1) minimum of 30 semester hours including a thesis of 6-8 semester hours, 2) minimum of 32 semester hours including a report of 2 semester hours of research or of problem work on a topic in the major field, or 3) minimum of 33 semester hours including evidence of scholarly effort.

To complete the Ph.D., a minimum of 90 semester hours beyond the B.S. degree are required. An M.S. degree is required for entrance into the doctoral program; and foreign language proficiency and several major examinations (oral and written) are to be completed prior to admittance to candidacy in the Ph.D. program.

CURRENT FACULTY, STUDENTS, GRADUATES

Of the 16.3 faculty lines assigned to the Department of Mechanical Engineering, 14.6 of the time allotted to those lines is given to teaching and 1.7 to research. No faculty member has more than 20 percent of his/her time funded by research. Faculty members serve approximately 276 undergraduate majors, 13 M.S. and 7 Ph.D. full-time students, and 4 M.S. and 4 Ph.D. part-time students. The number of graduates annually from all three degree levels is relatively stable (50 B.S., 10 M.S., 2 Ph.D); recently, however, the department experienced an abrupt fluctuation with a 65 percent increase in enrollment over the last four years.

Graduates are usually traced through Alumni Association records; but a project "Epilog" sponsored in conjunction with the American Society for Engineering Education is following graduates of KSU's program for three years upon completion of their degrees.

Financial support for undergraduates, in addition to standard loan programs, is minimal and administered through endowment funds of the department. Ten graduate students receive state support and five more are funded through current research projects. All graduate students are currently on some type of assistantship ($350/mo) unless they are financed by their own governments.

Faculty perceptions are that virtually all students obtain employment in their field of training. According to KSU personnel contacted in Mechanical Engineering, the Mechanical Engineering degree "sells" better than a more specific option (e.g., petroleum engineering). Approximately 144 companies interview on campus each semester.

PROGRAM PROJECTIONS

The program in Mechanical Engineering has been on the Kansas State campus since the early 1900s and gained accreditation at the B.S. level in 1936. With enrollment and research monies increasing, three additional faculty members are expected to be added over the next three years in thermal science, machine design, and automatic controls. Given the department's commitment to basic mechanical engineering degrees, no major curriculum changes are forecast.

COURSE DESCRIPTION

Undergraduate and Graduate courses:

560 527 Heat Transfer - Fundamentals of conduction, convection, and radiation; principles of heat exchanger design and dimensional analysis. (3 s.h.)

560 560 Engineering Economics - Economic analysis of problems as applied in engineering. (3 s.h.)

560 575 Mechanical Engineering Design Laboratory - Application of the principles of the design process in the solution of engineering industrial-type problems with direct involvement of industry. (2 s.h.)

560 662 Environmental Engineering I - Psychrometry; heating-cooling system design; air quality measurement and control; effect of air pollution. (3 s.h.)

560 625 The Man-Environment System - Basic structure and performance of the human, viewed as a component in information processing and control systems. Effect of visual, auditory, and thermal environments. (3 s.h.)

560 719 Engineering Acoustics I - A study of elementary engineering acoustics and its application to the measurement and control of sound and noise, including laboratory exericises. (3 s.h.)

560 722 Environmental Engineering II - Study and analysis of environmental factors and man's response to these factors; air pollution, air cleaning, biological heat transfer; factors affecting comfort, health, learning, and productivity. (3 s.h.)

560 742 Fine Particle Technology - Definition, theory, and measurement of particle properties, particle dynamics, size distribution and characteristics of powders encountered in particle transport, gas cleaning, air pollution sampling and particle processing; the physics of air ion generation, transport and decay; and requisites of accurate sampling of air-borne contaminants. (3 s.h.)

560 819 Engineering Acoustics II - A study of the generation, propagation, and reproduction of sound, with applications to the transmission and reduction of sound in materials and structures, and the design of acoustic enclosures and filters. (3 s.h.)

Graduate courses:

560 850 Advanced Power Plant Engineering - An advanced course in the economic problems in the design of power plants and in the generation of power, selection of equipment, choice of station heat balance, generation of by-product power in industries, and interconnections between utilities and industrial plants for the economical interchange of power. (variable s.h.)

560 916 Advanced Topics in Mechanical Engineering - A course reserved for study of current topics in Mechanical Engineering. Particular subject areas which may be included are: air conditioning, automatic controls, biomedical engineering, energy conversion, engineering design, environmental engineering fluid and gas dynamics, heat transfer, kinematics, thermodynamics and vibrations. (variable s.h.)

560 943 Radiation Heat Transfer - Basic theories of thermal radiation, shape factors; exact and approximate solutions of integral equations for radiation heat transfer between solid surfaces with absorbing or non-absorbing medium. (3 s.h.)

INSTITUTION: KIRKWOOD COMMUNITY COLLEGE (KCC)

PROGRAM: Environmental Health Assistant
Environmental Health Technician
DEPARTMENT: Environmental Science and Pollution Control
DEGREE: Diploma (Environmental Health Assistant)
Associate of Arts [A.A.] (Environmental Health Technician)

CONTACT: Larry Willis, Career Education
Linn Hall
Kirkwood Community College
Cedar Rapids, Iowa 52406
(319) 398-5498

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This program began in 1968 and trains people to monitor and enforce health standards and codes in order to safeguard the public health. This function is required by each of the 99 counties in Iowa. Other positions could be with city and county boards of health, housing improvement agencies, private industries, state environmental quality departments, state departments of agriculture, private laboratories.

PROGRAM REQUIREMENTS

For admission, a copy of the high school diploma is required along with an official transcript of each college or university attended.

Environmental Health Assistant requires 53 quarter hours, 19 related hours, and 4 quarters to complete. Environmental Health Technician requires 71 quarter hours, 46 related hours and 6 quarters to complete.

Related courses include chemistry, algebra, microbiology, physics, communication skills, government, and psychology.

CURRENT FACULTY, STUDENTS, GRADUATES

Faculty consists of one instructor and one coordinator. Fourteen students are enrolled in the assistant's program and five in the technician's program. There were eight and five graduates respectively (yearly).

Graduates receive employment in local health departments, departments of agriculture, and state health departments as technicians. Some graduates (25 percent) receive further training, usually leading to a Bachelor of Science degree.

PROGRAM PROJECTIONS

Program modifications are in the planning stages. A new focus will be geared to business, government and industry, attracting a new type of student and to help the attrition rate. The program is being designed for more flexibility. The new emphasis will include more courses to choose from and a variety of options.

ADDITIONAL INFORMATION

An advisory committee consists of 17 people. These men are located in the field and are often directors of county health departments.

In the past, training modules have been developed for business, industry, the Comprehensive Employment Training Act (CETA), and the Manpower Development Training Act (MDTA) pertaining to occupational health and safety. This has been in response to the changing needs of government, business, industry and the need for continual up-date of information for those in the field.

COURSE DESCRIPTION

EV004U Introduction to Environmental Health - Offers an overview of the organized community effort to overcome disease and upgrade the level of health of the public. (3 q.h.)

EV015U Insect and Rodent Control - Includes the identification of insect and rodent pests, how they spread disease, and the control procedures with special attention to sanitary practices and the judicious use of insecticides. (3 q.h.)

EV012U Private Wastewater Systems - Emphasizes small water - borne wastewater disposal systems. Design and evaluation of such systems to include systems in tight soils. (5 q.h.)

EV016U Private Water Systems - Considers source and protection of private water supplies. Also considers water quality, sanitary survey and water sampling, bacterial and chemical examinations of water. (5 q.h.)

EV013U Supervised Field Studies - Offers supervised on-the-job training in inspection procedures, complaint investigations, food, water and milk sampling, report writing, and administration in a typical work environment. (10 q.h.)

EV014U Seminar: Environmental Health - Studies problems encountered during field learning experience. (2 q.h.)

EV018U Air Quality Management - Considers the sources of air pollution, the classification of pollutants, the meteorological aspects, the effects of atmospheric pollution, the prevention/control of air pollution, and monitoring of pollutants. (4 q.h.)

EV017U Environmental Health Administration - Includes such topics as governmental aspects of public health, legal considerations, organizational considerations, personnel factors, fiscal management, and public relations. (4 q.h.)

EV019U Radiation Control - Covers fundamentals of radiation, biological effects of radiation, types of X-ray units, common hazards, radioactive sources, radiation protection, disposal of radioactive wastes, and environmental radiation surveillance and monitoring. (3 q.h.)

EV007U Milk Sanitation - Includes the quality milk program; the sanitation involved in the production and the processing of milk; and proper sampling technique. (5 q.h.)

EV006U Food Sanitation - Includes the relationship of food and the preparation and handling of food to the health of the public, and sanitary requirements of food handling establishments. (4 q.h.)

EV008U Occupational Health and Industrial Safety - Includes routine monitoring of safety, health and hygiene conditions in the work place, controlling work practice and working conditions, writing necessary reports, and recommending appropriate action. (4 q.h.)

EV009U Recreational Sanitation - Covers the health and safety aspects of parks, trailer parks and swimming pools including regulation enforcement and testing. (4 q.h.)

EV010U Solid Waste Management - Covers the character of solid waste produced by households and communities; their health and nuisance significance; and proper methods of disposal including use of landfills, incinerators, and grinders. The hazard of hog feeding and the air pollution and vermin problems associated with refuse burning and dumps also will be covered. (5 q.h.)

EV005U Institutional Sanitation - Covers environmental factors involved in the health and safety considerations in schools, nursing homes, hospitals and correctional institutions. (3 q.h.)

EV003U Public Water Systems - Considers operation and evaluation of public water supply and treatment system. (4 q.h.)

EV002U Public Wastewater Systems - Considers the operation and evaluation of public wastewater treatment systems. (4 q.h.)

INSTITUTION: LAMAR UNIVERSITY

PROGRAM: Environmental Science

DEPARTMENT: Interdisciplinary

DEGREE: Bachelor of Science (B.S.), Master of Science (M.S.) in Environmental Science

CONTACT:
Dr. Ewin A. Eads
Director of Environmental Studies
P.O. Box 10208
Beaumont, Texas 77710
(713) 838-7320

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Approved in 1964, the B.S. degree program in environmental science at Lamar trains students to implement the current laws and their regulations which control the quality of the environment. Specifically, studies emphasize all sources of air emission and wastewater discharges, controlled by these regulations.

The program is interdisciplinary in nature with a strong emphasis in biology, chemistry and civil engineering. Courses in general biology, microbiology, ecology, parasitology and limnology, general analytical, organic and physical chemistry are offered. Graduates of the program find employment opportunities in industrial and domestic air and water pollution, environmental planning, water/wastewater treatment research, management of air and water resources or occupational health fields.

Although the program has definite requirements, students are allowed great flexibility in the design of curricula. A unique feature about the environmental studies program at Lamar is the generation of funds by the students. Through industry and private foundations, over $25,000 for student support is received annually, in the form of research and training grants. However, federal support of the program is almost nonexistant.

PROGRAM REQUIREMENTS

High school graduates who have met the university requirements may major in environmental science. Students are required to complete 24 units in biology, 34 units of chemistry, 15 units of English, 15 units of math, eight units of physics, six units in government, six units in civil engineering, two units in physical education, three units of open electives and six units of chemistry electives, plus six units of biology or civil engineering electives. Internships are not required but strongly encouraged. Juniors and seniors have the opportunity to participate with industry in the areas of water and wastewater treatment and/or analysis and air pollution control. The majority of students in the program participate in the intern program at some point in their training.

CURRENT FACULTY, STUDENTS, GRADUATES

The current number of faculty involved in the program is 10. Each one is a member of one of the departments at the university and salaried from their respective departments. Only the Chairman of the Environmental Science program is cost-centered.

Enrollment in the program is steadily increasing. Currently, there are 125 students enrolled. Many of the students carry double majors, i.e., they major in chemistry and environmental studies. The program attracts a large number of career change students from engineering, chemistry, biology and pharmacy. Enrollment in the program is average compared to the rest of the science department. The average number of graduates ranges from 12 to 20 per year.

Approximately 5% of the students continue for a M.S. degree. The students that seek employment have no problem securing jobs in their field. Virtually 100% of the students have jobs on graduation, with 90% going to the private sector and 10% to government.

PROGRAM PROJECTIONS

At present, there are plans to expand the Bachelor's program in the food service and public health sectors. The M.S. program in environmental science will be expanded and eventually Lamar will offer a Ph.D. program in environmental science.

The number of faculty is expected to increase in the next three years with two Ph.D.s needed in the area of air resources and one Ph.D. with expertise in water quality. Lamar also offers seminars every semester for local wastewater operators. These types of programs are also expected to increase depending upon forthcoming funding.

COURSE DESCRIPTION

Chm 130 Introductory Environmental Science - Fundamental concepts of environmental systems as related to urban affairs and man's environment. Air, water and soil pollution with control methods related to the modern technological society. (4 s.h.)

Chm 241 Quantitative Analysis - Theory and practice of analytical chemistry, utilizing gravimetric and titrimetric techniques. (4 s.h.)

Chm 333 Inorganic - Generalization involving atomic and nuclear theory; properties of the elements; non-aqueous solvents, acids, bases, oxidation-reduction, etc. (3 s.h.)

Chm 334 Air Analysis - Theory and practice of chemistry as required in determination of ambient air quality. (3 s.h.)

Chm 341 Organic - Current theories and chemical principles as they relate to the field of structure and reaction of the various types of organic compounds. (4 s.h.)

Chm 410 Seminar in Environmental Science - Reports and assigned reading. (1 s.h.)

Chm 434 Air Pollution Surveys - Chemical, physical, meterological, biological, bacteriological and epidemiological factors as applied to determine the extent of environmental damage from air pollution. (3 s.h.)

Chm 438 Radiochemistry - Basic concepts of nuclear science. Principles and use of radiation measuring devices. (3 s.h.)

CE 331 Environmental Science - Introduction to the hydrologic cycle and the chemistry and microbiology of the natural aquatic environment, with emphasis on the physical, chemical, and biological aspects of water and wastewater systems in relation to man's environment. Laboratory work in the physical, chemical, and biological analysis of water and wastewater. (3 s.h.)

CE 433 Environmental Health Engineering - Problems of public health in rural, urban, and industrial centers with water, housing, heating, cooling, ventilation, milk, food, insects and rodents. Bio-statistics and public health laws, ordinances, and regulations. (3 s.h.)

INSTITUTION: McNEESE STATE UNIVERSITY

PROGRAM: Environmental Science

DEPARTMENT: Microbiology

DEGREE: Bachelor of Science (B.S.), Master of Science (M.S.) in Environmental Science

CONTACT: Dr. Victor Monsour
Chairman, Department of Microbiology
McNeese State University
Lake Charles, Louisiana 70609
(319) 477-2520 x 281

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental science programs at McNeese State University are administered by the Department of Microbiology. Two degree options are available: the Bachelor of Science and the Master of Science degrees in environmental science. The baccalaureate program was instituted in 1967 with a total of four students in the first class. The master's degree program was organized and established in 1971 with a total of 25 students in the first graduate class.

Although the programs are administered and conducted through the auspices of the Department of Microbiology, the emphasis is on an integrated approach to the problems of pollution control and abatement. Other department, therefore, contribute to the overall structure. Agriculture, chemistry, social science, biology and engineering cooperate in an effort to impart a broad-based science background to the students. The major area of study, however, is microbiology and its applications to the problems and solutions of environmental pollution.

Extensive research opportunities in microbiology are available to faculty and students. Current research activities, in part, include topics such as: biological deammonification; resource recovery from solid waste; nitrate content of airborne particulates; and, subterranean saline intrusion resulting from removal of ground water for irrigation and industrial purposes. Selected students are offered opportunities to assist with projects of these types.

Although the program does not attract adult career-change students, the program does attract program-change students from the areas of engineering, biology and education. A wide variety of students apply for admission to the program. Approximately 15 to 20 U.S. students and an equal number of foreign students, seek admission annually, especially at the graduate level.

PROGRAM REQUIREMENTS

Admission to McNeese State University is granted pursuant to the requirements of the university. In the case of graduate students, admission by the university must be followed by acceptance at the departmental level.

The Bachelor of Science degree is awarded to those students who successfully complete the general academic requirements of the university and also fulfill departmental requirements.

The environmental science baccalaureate student will complete 127 semester hours, 66 of which are lower division. Included in the lower division program is: ES 101, 102, 201, and 202; 22 semester hours of English, social studies and general electives; 24 semester hours of chemistry, microbiology and biology; and, eight semester hours of mathematics.

In the upper division, students are required to successfully complete the following: 20 semester hours of chemistry, microbiology, nuclear science, biology and physics; 19 semester hours of electives, psychology and sociology; 19 semester hours of environmental science; and, three semester hours of biostatistics.

The Master of Science degree includes the following requirements: 16 semester hours of microbiology and environmental science; eight semester hours of microbiology and environmental sciences; eight semester hours in microbiology and approved related fields; and, six semester hours for the thesis. The environmental science student may substitute 12 semester hours of approved environmental science courses for the thesis requirement. The total required semester hours of course work including thesis is 30, and without thesis 36.

CURRENT FACULTY, STUDENTS, GRADUATES

The current faculty complement for the environmental science programs includes five full-time, cost-centered personnel. In addition, there are two part-time faculty members (one attorney, and one public health official) who assist with the teaching requirements of the regular faculty. The department also utilizes the expertise of four graduate research assistants.

At present, there are 17 male and six female full-time students, and four part-time students, enrolled in the baccalaureate program. The master's level enrollment currently includes 22 full-time graduate students, of which approximately 82% are male.

The number of students awarded degrees from the environmental science programs has remained relatively stable over the last few years. On the average, approximately 10 per year earn the Bachelor of Science degree, while approximately seven are annually awarded the Master of Science degree.

Each year an average of 8% of the baccalaureate students elect to pursue the master's degree. Texas A & M, the University of Texas and the University of Mississippi are several of the schools which are the receipients of these graduates. Of the master's level students, approximately 14% annually choose to continue their education at the doctoral level.

Those students who choose a career path upon completion of their studies, find employment in the private sector. Employment opportunities are available to these graduates in the environmental pollution control and abatement areas of air, water, energy, and solid waste. A broad spectrum of occupations usually attracts these graduates.

PROGRAM PROJECTIONS

The programs at McNeese State University have become stabilized in regard to faculty, students and course offerings. The baccalaureate program is anticipated to illustrate some growth over the next few years. The graduate program is not expected to change significantly, however, in any of these respects.

COURSE DESCRIPTION

Undergraduate courses:

ES 101 General Environmental Science - An introduction to the relationship of man's environment to his health. (3 s.h.)

ES 102 General Environmental Science - A continuation of the study of the relationship of man's environment to his health. (3 s.h.)

ES 201 Physical Pollution - An introduction to the major categories of physical pollution of our environment. (2 s.h.)

ES 212 Water and Wastewater - A study of the role of microorganisms in water and wastewater. (4 s.h.)

ES 301 Microbiology of Foods - A study of microorganisms in natural and processed foods; their origin, nature, and effects on foods and the consumer. Federal regulations on processing and packaging are included. (4 s.h.)

ES 321 Consumer Product Protection - Consumer protection relating to current problems including food additives, automobile safety, flammable fabrics, hazardous toys, and misleading advertising. (3 s.h.)

ES 361 Ecology - A study of the ecologic principles as they apply to microorganisms and their environments. Discussions include such phenomena as antagonism, commensalism, symbiosis, and parasitism. (4 s.h.)

Graduate and approved for graduate study courses:

ES 401 Solid Waste Disposal - An introductory course dealing with the types of solid wastes and the current methods for their disposal. (2 s.h.)

ES 411 Ocean Pollution - A detailed study of the various ways in which ocean pollution occurs and how it can affect man and his ecologic environment. (3 s.h.)

ES 421 Air Pollution - An introductory study of the various groups of air pollutants. Methods of field sampling and laboratory testing are included. (4 s.h.)

ES 431 Field Study - Advanced students will visit various installations with a registered sanitarian on routine inspection tipes. May be repeated once for credit. (3 s.h.)

ES 441 Environmental Toxicology - The effects of selected environmental toxicants upon the health of humans. (3 s.h.)

ES 451 Environmental Impact Statements - Previously approved environmental statements are analyzed in detail for content, format, and legal implications. Students are given hypothetical design projects for which impact statements are to be written. (2 s.h.)

ES 461 Aquatic Chemical Processes - A detailed introduction to the physical and chemical processes affecting the distribution and circulation of chemical substances in natural and polluted waters and to the processes involved in water treatment. (3 s.h.)

ES 471 Problems - The advanced student is assigned a research problem in the field. This course may be repeated but one may not accrue more than 6 sem. hrs. of credit toward his degree. (1-3 s.h.)

ES 481 Seminar - Students are assigned topics for formal classroom presentation. This course is required for graduation by all environmental science majors. A student may not accrue more than 3 sem. hrs. of credit toward the degree. (1 s.h.)

ES 494 Environmental Laws - An introductory course in the laws concerning environmental protection. Prerequisites: Senior standing and permission of head of department. (3 s.h.)

ES 501 Solid Waste - A detailed study of the types of solid wastes and the mechanisms for their disposal. (3 s.h.)

ES 502-503 Environmental Science - A study of man's relationship to his environments as the atmosphere, biosphere, hydrosphere, and lithosphere. (3 s.h. each)

ES 511 Air Pollution - A study of the various types of pollutants being discharged into the atmosphere and the mechanisms for their control. (4 s.h.)

ES 521 Stream Pollution - Chemical - A study of the various groups of chemical pollutants and the mechanisms for their control. (4 s.h.)

ES 541 Physical Pollution - A study of the mechanisms for creating and controlling physical pollution of our environment. (2 s.h.)

INSTITUTION: MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PROGRAM: Environmental Engineering

DEPARTMENT: Interdepartmental

DEGREE: Environmental Engineer (Env.E.)

CONTACT:
Dr. Peter S. Eagleson
Chairman, Interdepartmental Environmental
Engineer Degree Committee
School of Engineering
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139
(617) 253-2725

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering at MIT is an interdisciplinary program administered by the School of Engineering and composed of faculty from the various engineering departments and from other relevant departments throughout the Institute. The program was initiated in 1973 and provides preparation in an environmentally related area of engineering and a background in the relevant area of social science, management, and law.

The degree of Environmental Engineer is a professional degree which goes beyond the Master's level but does not have the research emphasis of the doctorate. Students entering this program normally register in one of the engineering departments and plan their own programs of study which must be approved by a faculty advisor. Research facilities of the various engineering departments are used in support of the program.

PROGRAM REQUIREMENTS

Admission to the environmental engineering program is available by registering in any of the departments in the School of Engineering. General admission requirements include a bachelor's degree or equivalent from an acceptable college, university, or technical school with demonstration of an ability to accomplish a program of study and research.

The Environmental Engineer degree requires the completion of one hundred and sixty-two subject units. This includes sixty-six units in basic engineering, a minimum of twenty-five units in environmental engineering in one of three areas: air quality, water quality, or natural resource utilization, five subjects with at least forty-two units in environmental policy, up to twenty-nine units of electives and a thesis worth twenty-four units.

CURRENT FACULTY, STUDENTS, GRADUATES

Because of the interdepartmental structure of the program and the vast number of environmentally related subjects offered in the School of Engineering, it is impossible to tell exactly how many faculty members are involved in the program. Faculty members of the School are responsible for research as well as teaching in their primary fields. Several sources provide research funding for the program, including the National Science Foundation, the National Aeronautics and Space Administration, the National Weather Service, the U. S. Geological Survey and the Rockefeller Foundation.

The program has a current enrollment of three full-time students. Most have backgrounds in civil or nuclear engineering physics. No specific recruiting is done by the program. Many students have come from master's programs in one of the engineering departments and become interested in environmental topics. Almost all students receive some form of finanacial assistance, primarily research assistantships. A few training grants and fellowships are also available.

An average of two to three students complete the program each year, and this number is expected to remain stable. Approximately fifty percent of the graduates work in the private sector, usually for consulting firms. The remainder find employment with government agencies or research work. Graduate placement is usually through students or faculty contacts with employers.

PROGRAM PROJECTIONS

No real expansion in the program or faculty is anticipated in the near future although program officials indicated that there is some need seen for an undergraduate program.

COURSE DESCRIPTION (SELECTED)

1.731 Water Resources Systems I - Introduction to the fundamentals of water resources systems analysis, involving the determination of the optimal dimensions, target out-puts, and operating policies of water resource projects. (3 s.h.)

1.77 Water Quality Control - Analysis of environmental engineering problems in water quality and pollution control technology. Emphasis on predicting the distribution and fate of effluents discharged into lakes, reservoirs, rivers, estuaries, and oceans. (3 s.h.)

1.78 Water Quality Management - Systematic approach to the management of water quality. Identification of major issues and problem areas. Type, sources, and stochastic nature of waste materials and their effect on water bodies. (3 s.h.)

1.811 Environmental Law: Pollution - Review and analysis of common law, legislation, and regulation for pollution control. Focus on programs, analytical and decision processes for controlling water, air, and noise pollution, and the emission of toxic materials. (3 s.h.)

2.284 Water Purification - An introduction to water resource, water quality parameters and pollutants. Outline of various water purification processes and economic considerations for water supply and wastewater treatment. (3 s.h.)

10.17 Air Pollution Fundamentals - Introduction to the causes, effects, and control of air pollution with emphasis on combustion generated pollution and industrial process sources; origin and fate of air pollutants; air pollution meteorology; combustion processes and the formation of gaseous and particulate pollutants; air pollution control principles; measurement methods for gaseous air pollutants and for particulates. (2 s.h.)

19.03 Meteorologic Aspects of Air Pollution - Primary emphasis on the physical processes involved with motion and dilution of material released into the atmosphere. (3 s.h.)

22.37 Environmental Impact Power Production - An assessment of the various environmental impacts of producing thermal and electric power with currently available technology. (3 s.h.)

INSTITUTION: MICHIGAN STATE UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil and Sanitary Engineering

DEGREE: B.S. in Civil Engineering (emphasis in Environmental Engineering)
M.S. in Sanitary Engineering
Ph.D. in Sanitary Engineering

CONTACT: Dr. Mackenzie L. Davis
Department of Civil and Sanitary Engineering
College of Engineering
Michigan State University
East Lansing, Michigan 48824
(517) 353-6847

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Undergraduate majors in Civil and Sanitary Engineering at Michigan State University can specialize in environmental engineering, while graduate programs in Sanitary Engineering emphasize water supply, process design of water treatment plants, biological aspects of wastewater treatment, air pollution, and problems of eutrophication. The graduate program generally has a strong emphasis in hydraulics and environmental fluid mechanics. The course offerings at all levels reflect an expansion of the essentially "water-oriented" civil engineering curriculum to encompass air, solid waste, and radiological health areas. At the same time, the Department has responded affirmatively to the recommendations of the Third National Environmental Engineering Conference by providing more courses at the undergraduate level.

Facilities include standard analytical laboratories for teaching and research, biology and chemistry laboratories devoted primarily to research, and a pilot plant laboratory which is connected to a raw sewage line and wastewater supply enabling students and staff to conduct treatability studies on water and wastewater. The Department co-sponsors regularly with the Michigan Department of Public Health and the American Waterworks Association seminars on groundwater chemistry and groundwater hydrology. It periodically offers a workshop on solid waste.

PROGRAM REQUIREMENTS

Undergraduate Civil Engineering majors must complete 180 quarter hours in humanities, social sciences, mathematics, basic sciences, and civil engineering (basics, design, concepts, and analysis). Entrance to the M.S. degree program demands completion of courses, or equivalents, in computer programming, chemistry, microbiology, environmental engineering, civil engineering, hydraulics sytems, and water and wastewater analysis and treatment. Also, applicants must have a bachelor's degree in an accredited engineering or related program and an undergraduate grade point average of 2.8. For the M.S. degree, students must complete 45 credits beyond the baccalaureate degree. Each candidate is required to take 12 hours in one or more areas which are not his/her principle area of study (i.e., sanitary engineering). Areas include chemical engineering, chemistry, environmental law, hydraulics, management, microbiology and public health, crop and soil science, and water resources.

The communication skills of the graduates of this program are important elements in their training. Though additional coursework may be substituted for the master's thesis, all students must prepare a scholarly paper, participate in technical seminars as a speaker and critic, and participate and report on 24 hours of field observation. "The objective of these requirements is to develop three skills which are not attainable in the normal classroom situation . . . (1) independent research and technical writing, (2) oral presentation of technical material, and (3) the power of critical observation and reporting." The field observation entails a minimum of eight hours in both a municipal water treatment plant and wastewater treatment plant. The remaining eight hours may be spent at any one or more of the following: industrial waste treatment plant; government office, laboratory, or field study; public hearing on environmental issues; consulting firm office; or municipal, county, or state legislative government meeting, including a court of law where an environmentally related suit is being argued.

A student may be admitted to a doctoral program if he/she has successfully completed a master's degree or the equivalent. In general, the program is structured to provide a comprehensive knowledge of environmental engineering and related subjects and involves one year of coursework and one year in preparation of a dissertation based on original research.

CURRENT FACULTY, STUDENTS, GRADUATES

Three full-time faculty share responsibilities for the Environmental Engineering program. At the present time, there are approximately 60 undergraduates (juniors and seniors) in the Civil and Sanitary Engineering Department specializing in Environmental Engineering, 11 M.S. candidates, and 2 doctoral students. Averages for the past three years indicate that 10 M.S. and 2 Ph.D. students are enrolled annually in the Sanitary Engineering graduate program.

Baccalaureate students in the upper 10% of their class usually continue on for graduate studies at Michigan State and elsewhere. Approximately 80% of those students completing any given degree program take consulting jobs, 2% take industry jobs, and 18% enter government work. The market for women engineers in industry is particularly good. A limited number of teaching and research assistantships are open at the graduate level; other students support themselves through loans and part-time work or in the case of foreign students, with aid from their home governments. Undergraduates, if they choose, are placed in cooperative work programs related to their training (degree takes five years).

PROGRAM PROJECTIONS

The objective of the Michigan State program in Environmental Engineering is to produce "problem-solving" professionals. Training in Sanitary Engineering at M.S.U., and nationally, is broadening its focus to include air, solid waste, and radiological health areas in its curriculum. Enrollment appears stable for the next five years with projected increases over the next decade. Though the program is essentially without frills, faculty believe it offers a good, solid training to the students it serves.

COURSE DESCRIPTION*

Civil Engineering:

280 Introduction to Environmental Engineering - Hydrology; ground water and surface water supply systems; wastewater treatment, methods of pollution control for solid waste, air, and noise. (4 q.h.)

321 Introductory Fluid Mechanics - Fluid properties; hydrostatics; control volume approach to conservation of mass, momentum and energy; dimensional analysis and dynamic similitude; fluid resistance; pipe and open channel flows; boundary layer concepts. (5 q.h.)

421 Hydrology - Engineering hydrology; frequency and precipitation analysis; streamflow analysis and the unit hydrograph; flood precipitation; rainfall-runoff correlations; urban hydrology. (4 q.h.)

422 Hydraulic Systems - Steady flow in pipe networks; open channel flow; turbomachinery; groundwater hydraulics; introduction to unsteady flows. Applications to water supply systems; aquifer analysis; surges and water hammer. (4 q.h.)

481 Water and Wastewater Analysis - Quantitative analysis; bacteriologic and chemical characteristics of water and wastewater; principles of softening, iron removal, coagulation and chlorination; laboratory examination of water and wastewater including turbidity, solids, coliforms, chlorine, etc. (4 q.h.)

483 Water and Wastewater Treatment - Water treatment theory and design including sedimentation, coagulation, softening, iron removal and chlorination; wastewater treatment theory and design including grit chambers, activated sludge, trickling filter, and anaerobic digesters. (4 q.h.)

485 Environmental Health Engineering - Epidemiology of communicable disease transmitted by air, water, food and arthropods. Engineering measures to control disease spread. Incidence and prevalence rates, well design, cross-connections, disinfection, sanitary inspection. Case studies. (3 q.h.)

800 Operations Research Techniques for Civil Engineers - Elements of deterministic methods of operations research with emphasis on computational techniques and applications to civil engineering problems such as structural design, water supply, transportation, and construction management. (3 q.h.)

809 Finite Element Method - Theory and application of the finite element method to the solution of continuum type problems in heat transfer, fluid mechanics, and stress analysis. (4 q.h.)

827 Environmental Fluid Mechanics - Review of turbulent flow and transport processes in water quality control. Analysis and solution of ecological problems related to diffusion and disposal in rivers, estuaries, lakes, and the ocean environment. (4 q.h.)

828 Open Channel Flow - Fundamentals of free surface flow; steady uniform and nonuniform concepts; energy and momentum principles; subcritical and supercritical regimes; gradually and rapidly varied flow; design applications. (3 q.h.)

Sanitary Engineering:

802 Physical Chemical Processes of Environmental Engineering - Analysis of physical and chemical principles which form the basis of air and water pollution control and solid waste disposal; process dynamics, sedimentation, coagulation, filtration, adsorption, absorption, oxidation. (4 q.h.)

804 Biological Processes of Environmental Engineering - Aerobic and anaerobic degradation of liquid and solid wastes. Biochemical reactions; activated sludge and trickling filter kinetics; sludge digestion, and composting. (5 q.h.)

812 Water Treatment Plant Design - Theory and design of water treatment processes. Coagulation and flocculation; softening; sedimentation; filtration; disinfection. (4 q.h.)

814 Wastewater Treatment Plant Design - Theory and design of wastewater treatment processes. Racks, screens, sedimentation basins, tricking filters, aeration tanks, digesters. (4 q.h.)

816 Treatment of Industrial Wastes - Theory of industrial waste management. Application of physio-chemical and biological treatment to selected industries. Examples include: apparel; food processing; materials processing and chemical industry. (3 q.h.)

822 Air Resource Management - Characteristics of air contaminants and noise; sources and source inventory; microclimitology and pollutant transport; pollutant effects, introduction to sampling and control. (4 q.h.)

922 Air Pollution Control - Application of physical and chemical principles to control of gaseous and particulate air pollutants.

922 (Cont'd) - Cyclones, bag houses, electrostatic precipitators, adsorption, absorption, combustion. (4 q.h.)

924 Air Sampling and Analysis - Theory and design of air sampling programs. Quantitative analysis of ambient air samples and stack samples. Analysis for sulfur oxides, nitrogen oxides and particulates. (4 q.h.)

Chemical Engineering:

806 Thermodynamics and Kinetics in Chemical Engineering - Mass and energy balances in batch continuous and open systems. Process thermodynamics. Cryogenics. Properties of substances and mixtures. Phase equilibria. Chemical reaction equilibrium. Chemical reactor kinetics. Process design orientation. (4 q.h.)

807 Transfer and Separation Processes - Momentum, energy, and mass transfer. Laminar and turbulent flow. Fluid friction. Dimensional analysis. Heat through stationary and flowing materials. Interchangers. Condensation. Boiling. Binary and multicomponent distillation, absorption extraction. (4 q.h.)

Crop and Soil Sciences:

442 Soil Microbiology - Major groups of microorganisms of importance in soils are studied with emphasis on ecological, biochemical, and physical aspects. (3 q.h.)

840 Soil Physics - Physical properties of soil (texture, structure, consistency, aeration, water, temperature, etc.), their quantitative measurement, and relation to plant growth, and agronomic and engineering practices. (5 q.h.)

850 Soil Chemistry - Chemistry of mineral weathering and soil formation, ion activities, ionic exchange and equilibrium reactions, soil pH, specific elements and their chemical analysis, and availability of nutrients to plants. (5 q.h.)

Fisheries and Wildlife:

875 Chemical Limnology - Application of analytical chemistry concepts and technologies to fundamental chemical mechanisms in natural and polluted water systems. Special consideration given to selected heterogeneous equilibria. (4 q.h.)

Resource Development:

420 Water Resource Development - Significance of water resources in modern society. Introduction to the needs of industry, agriculture, and recreation. Concepts of development, use and conservation are critically evaluated in terms of future needs. (4 q.h.)

832 Natural Resource Law - Legal principles of natural resources administration. Focus on natural resource jurisdiction. Discussion of state and federal cases, statutes, and treaties. Constitutional and common law. Limitations on governmental power. (3 q.h.)

835 Water Resources Law - Legal principles affecting private rights in state and federal regulation on surface and ground waters. Emphasis on water quality controls. (3 q.h.)

836 Environmental Law I - Public and private legal controls and restrictions on resource use, including common law, nuisance and trespass, citizen suits, class actions, appeals from agencies, Administrative Procedure Act, National Environmental Policy Act. (3 q.h.)

837 Environmental Law II - Analysis of federal government laws (NEPA, WQIA, Clean Air Act). Form and content of Environmental Impact Statements and problem of agency discretion and judicial review. (3 q.h.)

*500-level courses and above are for graduate students.

INSTITUTION: MIDDLE TENNESSEE STATE UNIVERSITY

PROGRAM: Environmental Science and Technology
DEPARTMENT: Industrial Studies
DEGREE: Bachelor of Science (B.S.)

CONTACT: Dr. William Mathis, Coordinator
Environmental Science and Technology
Department of Industrial Studies
Middle Tennessee State University
Murfreesboro, Tennessee 37132
(615) 898-2778

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

A relatively new program, Environmental Science and Technology was begun in 1973 in response to the increasingly complex nature of environmental care. The program is designed to provide the student who is interested in employment in environmental pollution control a background of educational experiences related to environmental quality.

The Department of Industrial Studies administers the program, and it is conducted jointly by the Departments of Agriculture, Biology, Chemistry and Physics, and Industrial Studies. Courses for this interdisciplinary curriculum are in sciences and mathematics, agriculture and technology, and the liberal arts.

Graduates are qualified to pursue employment in the various levels of government and environmentally related agencies, and in the manufacturing, construction, and agricultural industries in areas such as air and water quality control, wastewater management and treatment, solid waste management and recycling, and in noise and radiation control. Graduates are also fit industrial hygienists, industrial supply supervisors, and forestry ecologists.

Recruitment activities take two forms; the first being the dispensing of literature to high schools, and the second being by way of Environmental Insights, which is a series of seminars offered each spring on a central theme. People from the university and the community at large are invited to attend these seminars. Enrollment has increased by 20 percent each year since its inception.

PROGRAM REQUIREMENTS

For admission, in-state applicants must have graduated from a state approved or regionally accredited high school and must have either a 2.0 average for three successive years or a composite score of 16 on the ACT Test. Out-of-state applicants must have either approved or accredited high school diplomas or must have obtained a forty-five or above composite score on the G.E.D. Test. In addition, they must have a composite score of 16 on the ACT Test.

General requirements for a major in Environmental Science and Technology are: a minimum of forty-four semester hours of biology, chemistry, and physics; a minimum of twelve semester hours of mathematics; and a minimum of eighteen semester hours of agricultural and industrial studies courses related to environmental problems. A minor in Environmental Sciences and Technology may be completed with eighteen semester hours of courses which have been approved by the program coordinator. During their junior and senior years, majors must attend one designated seminar in each of the four cooperating departments.

CURRENT FACULTY, STUDENTS, GRADUATES

One person is assigned to coordinate the program on a full-time basis. It is estimated that an additional nine persons from cooperating departments have teaching responsibilities to Environmental Science and Technology part-time. There are thirty-one students enrolled in the program, with an average of twelve graduates per year.

While no formal follow-up study has been conducted, it is estimated that 100 percent of the graduates are able to locate environmentally related employment. Commonly, students use the school's placement office and with good results. Sources feel that the most usual employer is the U.S. government. Approximately 10 percent of the graduates continue their schooling in graduate level programs.

PROGRAM PROJECTIONS

Responding to the need for alternate energy sources and for increased sophistication relative to current energy technologies, one survey course in energy will soon be offered. Additionally, the topic of energy as an option for concentration is being planned.

In order to create a sense of cohesiveness about this program, a freshman orientation course will be added to the list of program requirements shortly.

COURSE DESCRIPTION

Required Courses *

Geog 431 Conservation of Environmental Resources - Current problems related to use of environmental resources. Topics include: air, water, and other resources. (3 s.h.)

Agri 337 Analysis of Soils - Chemical and physical analysis of soils in the laboratory. Cation exchange capacity, soil acidity and lime requirements, organic matter, available water holding capacity, soil texture, quick tests for available phosphorus and potassium. (3 s.h.)

Agri 363 Forestry - Culture, conservations, management, and utilization of forest stands; forest product industries; forest history, agencies, and policies; multiple-use and forest resources. (3 s.h.)

Agri 434 Soils and Environment* - Environmental factors affecting origin, taxonomy, and utilization of soils. Principles of soil management, soil judging, physical geology. (3 s.h.)

Agri 370 Environmental Agriculture* - Technical agriculture as it relates to the environment. Role of agriculture in an environmentally conscious world. (3 s.h.)

Agri 435 Soil Surveys in Urban Planning - Soil properties, related pollution problems, land suitability, specific criteria, aesthetic value, and economic importance in evaluating the use of land and rural-fringe areas. (3 s.h.)

Chem 470 Introduction to Environmental Chemistry* - Quality of the environment relative to chemical changes through contamination or modification of air, water, and soil as affected by agricultural, industrial, and social activities. (3 s.h.)

Chem 471 Detection of Chemical Pollutants* - Theory and practice of methods of analytical chemistry which are used in pollution measurement. (3 s.h.)

Biol 211 Bacteriology* - Concepts and techniques pertaining to isolation, cultivation, morphology, reaction, physiology, and nutrition of bacteria. (3 s.h.)

Biol 307 Biology Seminar on Environmental Problems - Environmental problems: causes, effects, and solutions. (3 s.h.)

Biol 424 Ecology* - Basic concepts of the ecosystem and community, aquatic and terrestrial habitats and population ecology. (3 s.h.)

Biol 425 Limnology* - Biological, chemical, and physical aspects of freshwater lakes and streams. Interrelationships of organisms and the aquatic biotope. (4 s.h.)

IS 477 Water and Wastewater Technology* - Water pollution control technology. Legislative regulations and quality standards, pollution types and sources, detection and analysis instruments, and treatment principles and practices for liquid wastes. (4 s.h.)

IS 478 Air, Solids, and Noise Pollution Technology* - Introduction to air, solid waste, noise, and radioactive pollution technology. Legislative regulations and quality standards. Sources, detection, and analysis instrumentation and practices. Treatment and abatement principles, equipment and practices. (4 s.h.)

IS 476 A,B,C, and D Seminar in Environmental Science and Technology* - Interdisciplinary seminars conducted jointly by the Departments of Agriculture, Biology, Chemistry, and Industrial Studies. Guest lecturers, agency and resource personnel, readings, reflective thought, films, and discussions on environmental problems and issues, new and proposed legislation, and the role of environmental science and technology in pollution control. (1 s.h. each)

INSTITUTION: MIDDLESEX COUNTY COLLEGE

PROGRAM: Environmental Health Science Technology

DEPARTMENT: Science Division

DEGREE: Associate of Applied Science (A.A.S.)

CONTACT: Diane Trainer, Chemistry Department
Middlesex County College
Edison, New Jersey 08817
(201) 548-6000 extension 241

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Middlesex County College initiated its Environmental Health Science Technology Program in 1971 to train technicians as: laboratory technicians to perform air, water, and wastewater analyses; water and wastewater treatment plant operators, air pollution inspectors; stack samplers; public health enforcement officers (sanitorians and food and drug inspectors); and industrial hygiene technicians. Emphasis is placed to produce graduates with both flexibility and adaptability so they are able to work in more than one pollution control and abatement area.

This two year program stresses environmental laboratory training, and courses are integrated from biology, chemistry, physics, microbiology and other areas. The program offers advantages to students of low tuition, modern equipment and facilities, personalized laboratory supervision, and faculty with teaching and industrial experience.

PROGRAM REQUIREMENTS

In order to enter the Environmental Health Science Program, a prospective student must be a high school graduate, have one year of laboratory science and one year of Algebra. Structured into the two year, four semester curriculum are sixty-four credits of courses which include water and wastewater treatment, environmental microbiology, air pollution control, sanitary chemistry, industrial hygiene, and community sanitation. Six credits of humanities and social science electives must be taken within the present structure.

In the second semester of the second year, the students are employed for one day each week. However, they are not salaried and their primary function is one of observation. One college credit is received for their participation in this internship program. A log is kept by the student of the activities in which they participated and at the end of the period, the students immediate job supervisor writes an evaluation of the student's performance. This internship program has often enabled students to use the evaluations as letters of recommendation when later searching for employment or being offered jobs by their internship employer.

Financial aid from the State of New Jersey is available to students and a few receive work-study funding. Students also have access to other federal programs such as the Educational Opportunity Fund, ROTC, and the Basic Educational Opportunity Grant Programs.

CURRENT FACULTY, STUDENTS, GRADUATES

Four faculty members currently teach concepts of environmental science to students enrolled in the Environmental Health Science Program and all are full-time. The Program currently has an enrollment of 19 students, full-time, and four part-time. Four of the full-time students are female. Since the program was initiated in 1971, there has been a consistent graduating class of fifteen students.

About forty percent of the annual graduates transfer into other college or university environmental programs. Middlesex Environmental Health Science graduates often attend Bachelor degree programs offered by Rutgers, Stockton State College, Ramapo State College, New Jersey Institute of Technology, Michigan Tech, and San Jose State College. The College maintains a placement service and a job counseling service to assist students in their employment search. Program officials estimate that of ten total graduates, six found employment and four are college transfers. Of seven 1976 graduates surveyed by the College in 1976, six found employment in their field and one in a related field. Only one of the seven found employment with a governmental agency.

PROGRAM PROJECTIONS

Although College officials project that environmental programs are continuing to increase in number and size, the emphasis is mainly in specific areas, e.g. industrial hygiene, energy, and water. There are no current plans being made by College officials to expand the Environmental Health Science Technology Program because no real need exists at present. However, due to an increased enrollment, one additional faculty member will be recruited in 1978 to teach environmental science and chemistry courses.

COURSE DESCRIPTION

ENV 201 Advanced Wastewater I - Covers such topics as wastewater characteristics, flow measuring devices, physical treatment systems, and sludge digestion and disposal. (3 s.h.)

ENV 202 Advanced Wastewater II - Covers an approach to total treatment of wastewater. Prepares a student for the NJ State Wastewater Operators License. (3 s.h.)

ENV 203 Advanced Water Operations I - Sources of water and their characteristics, water cycle balance, reservoirs in NJ, surface and ground water supplies, methods of analysis, disinfection, tastes, and odors. (3 s.h.)

ENV 204 Advanced Water Operations II - Water treatment operations including pretreatment and filtration, distribution systems, records, budgeting, and supervision. ENV 203 and 204 must be taken to prepare a student for the NJ State Water Operators License. (3 s.h.)

ENV 205 Atmospheric Pollution - Community air pollution, stressing problems and the technology used for their detection and control. (3 s.h.)

ENV 207 Concepts of Environmental Science - A one-semester course for the career-oriented student that explores the possible causes and cures of all types of pollution in our society. (3 s.h.)

ENV 208 Community Sanitation - A survey of current community and environmental health problems with emphasis on communicable diseases, waste disposal, water and air pollution control, food sanitation and radiological health, and other topics. (3 s.h.)

ENV 211 Environmental Science I - Emphasis is on the water and air environment. Includes laboratory and field trips. (4 s.h.)

ENV 212 Environmental Science II - Focuses on solid wastes, noise, energy, radiation, and other miscellaneous environmental areas of concern. (4 s.h.)

ENV 222 Water and Wastewater Analysis - A systematic study of laboratory procedures as applied to water analysis and purification. (3 s.h.)

ENV 250 Environmental Internship - One day per week exposure to an environmental career. (1 s.h.)

ENV 220 Industrial Hygiene - This course examines the sampling and analytical techniques required to evaluate the safety and health hazards associated with the industrial environment. (3 s.h.)

INSTITUTION: MUSKINGUM AREA TECHNICAL COLLEGE (MATC)

PROGRAM: Environmental Quality Control Technology (air and water options)
DEPARTMENT: Division of Engineering and Science
DEGREE: Associate of Applied Science

CONTACT: Mr. Charles M. Woolf, Division Chairman
Division of Engineering and Science
Muskingum Area Technical College
1555 Newark Road
Zanesville, Ohio 43701
(614) 454-2501

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Quality Control Technology program offered at Muskingum Area Technical College is designed to train paraprofessionals to meet manpower needs necessitated by stricter legislation and enforcement of environmental quality standards. Graduates receive an Associate of Applied Science degree preparing them to work with professional biologists, chemists, engineers, and environmentalists in conducting air and water quality studies. Their work includes the collection and analysis of air and water samples for routine monitoring, special studies, and for insuring compliance with environmental quality laws.

During the second-year of this two-year program, students may choose two technical electives that provide them with a more intensive training in either air or water quality. However, students are now encouraged to take the technical electives under both options; and all students currently enrolled do so. All other coursework for the two options is identical. The college maintains analytic and mobile laboratories for each option area all equipped with a broad spectrum of instrumentation. The air laboratories permit meteorological and air sampling tests while the water quality labs allow water testing. Students learn to maintain and operate all of the equipment in these laboratories (10 to 15 percent of the equipment was donated by the Environmental Protection Agency). The meteorological recording station is the only one in a five-county area. Nearby industries cooperate in on-site visits by students to their facilities.

Environmental Quality Control Technology faculty have conducted workshops for the Ohio Environmental Protection Agency in the area of particulate analysis (air)and for high school students and and teachers on more general topics. State certification in microbiological particulate analysis is almost complete, and work toward certification in inorganic analysis will begin soon. As a service to public agencies, the program also sponsors a testing lab for the National Pollution Discharge Elimination System (NPDES) which gives students experience while in school for jobs upon graduation.

Curriculum oversight is provided by an advisory committee of local citizens in the environmental quality field. All students intern during the summer months in some form of employment related to their particular technological interests and receive college credits for this work. The environmental program presently has a special intern on-the-job arrangement with the City of Zanesville for outstanding students.

PROGRAM REQUIREMENTS

To obtain the Associate of Applied Science in either Air or Water Quality, the student must complete 110 quarter hours in basic sciences, mathematics, communication, social sciences, and, of course, environmental sciences. Admission to MATC requires a high school diploma or its equivalent.

CURRENT FACULTY, STUDENTS, GRADUATES

Two faculty members serve the 23 first-year and 13 second-year students currently enrolled in the program. The statistics on program graduates (six in 1976, nine in 1977) indicate an increasing number of students who are completing this course of study. Financial assistance consists of standard programs such as Basic Educational Opportunity Grants, Ohio Instructional Grants, College Work-Study, National Direct Student Loan, Supplemental Educational Opportunity Grants, and Ohio Student Loans.

On the average, over two-thirds of the Environmental Quality Control graduates gain employment in their technological field. There are no reported problems with placement though the faculty note that available positions in municipalities, consulting firms, industry, and the Environmental Protection Agency are limited to those requiring two-year graduates. The college cannot fill all the water and wastewater jobs listed at MATC. Employment opportunities come through the college placement office (each technology has its own placement officer), the student's internship experience, and the program's advisory committee. Jobs are available to graduates of this program in public health departments, pollution control equipment manufacturing, municipal water and wastewater treatment facilities, federal and state fish and wildlife departments, U.S. Corps of Engineers, private consulting firms, research laboratories, private industries, federal and state Environmental Protection Agency offices, and local environmental control boards.

PROGRAM PROJECTIONS

The faculty of the Environmental Quality Control department predict a stable future for their program. Depending on decisions by the Environmental Protection Agency and changing career opportunities, the program may shift toward more water-related courses (water distribution, wastewater, etc.). An additional staff member in biology will have to be hired in the next five years to meet enrollment demands.

A major concern of the staff at MATC is the lack of employer awareness of the capabilities of the two-year technician who has both practical skills and theoretical knowledge. Staff personnel contend that public support, training monies for students and workshops, and increased enrollments are essential in order to maintain the current environmental programs in the State of Ohio.

COURSE DESCRIPTION *

BIOL 141 Field Zoology and Ecology - A study of the animals common to this area, stressing identification and the environmental aspects which affect their distribution. The basic principles of ecology are covered with emphasis on the interrelationships between an animal and his physical and biological surroundings. (3 q.h.)

ENV 111 Industrial Processing and Pollution Control I - Prime emphasis will be the study of major manufacturing and industrial processes and products with orientation towards the origins of the pollutants and the engineering problems involved in their control. Each industry's air, water, and solid waste problems will be studied from the industrial engineer's viewpoint with emphasis on a total solution. (3 q.h.)

ENV 151 Introduction to Environmental Quality Problems - An introduction to environmental pollution, its effects on man, other animals, and plants. It includes discussion of the major pollution sources, and health and economic problems created by pollutants. (3 q.h.)

ENV 135 Earth Science - A study of the physical principles guiding the earth's development, including basic geology, weathering and land forms; the method of locating points on the earth and principles of mapping; principles of meteorology; interactions of abiotic and biotic components of the environment. (3 q.h.)

ENV 112 Industrial Processing and Pollution Control II - This is a continuation of ENV 111 looking at major industries and their unique problems associated with pollution control. (3 q.h.)

CHEM 111 Chemistry--Basic and Organic - designed to introduce the students to the basic principles of chemistry, atomic theory, CHEM 111 (Cont'd) - chemical bonding, reactions, and other aspects of preparatory chemistry. This course specifically meets the needs of field analysis and laboratory in environmental quality control. It will include studies of organic compounds as pollutant compounds. Laboratories will include testing techniques specific to environmental quality control. (4 q.h.)

ENV 121 Air Sampling and Analysis - A study of the standard techniques of ambient air sampling. This course shall include an understanding of the principles of operation and maintenance of air sampling equipment; an understanding of the analytical (quantitative and qualitative) techniques used to identify and measure air pollutants; experience in site selection and in collection of various types of air samples; practical experience in laboratory analysis of air samples by the standard methods of wet chemistry, colorimetric method, and instrumental analysis; and the interpretation of data collected and analyzed by the students. (4 q.h.)

ENV 171 Water Sampling and Analysis - The course is designed to give practice in water sampling techniques and chemical analysis (wet chemistry, instrumental analysis, and by portable test kits) of the water quality of streams and lakes. It also includes studies of new methods, techniques, instruments in field sampling and laboratory analysis, data interpretation, and reporting results. (4 q.h.)

ENV 251 Environmental Quality Laws and Enforcement - An analysis of existing environmental quality control laws, methods of establishment, and the enforcement practices of the different governmental agencies. (3 q.h.)

NS 200 Internship - Supervised work experience required for environmental sciences students. Includes student applying for job in related area, on-the-job supervision, scheduled visits by coordinators, and periodic evaluations. (7 q.h.)

NS 299 Seminar - Course taken in conjunction with Internship. Includes discussion of students' intern experiences, principles of employment practices, and improvement of employee traits. (3 q.h.)

ENV 271 Environmental Instrumentation - An introduction to the types of measuring means and their function, their operation, practical construction, and uses. Instrumentation terminology and measuring devices for temperature, flow rates, level control, pressure, other control devices, monitoring, and recording instruments are studied. (4 q.h.)

ENV 291 Water Treatment Techniques - The course is designed to provide the formal training to allow the student to attempt the State of Ohio Class One Operator Water Exam. The course will emphasize sources, water softening, water hygiene and

ENV 291 (Cont'd) - public health aspects, distribution systems, types of equipment and treatments, and budgetry. (4 q.h.)

ENV 235 Environmental Science Computer Applications - Introduction to computing sciences for the analysis and interpretation of environmental data and computer print-out. Simple statistical treatment of data is combined with the utilization of simple calculators, programmable calculators, the PDP-8 terminal computer, and the IBM 360-30 computer. Simple programming is combined with other computer operations such as keypunching and sorting, and the use of pre-programmed packages. (3 q.h.)

ENV 281 Environmental Health - An investigation into the activities of the state and local health departments including their role in setting environmental standards and methods of inspection for water, wastewater treatment facilities, air quality monitoring, insect vector and rodent control, pesticide use, radiation safety, milk and food service, and communicable disease control. (4 q.h.)

ENV 211 Emission Control Techniques - A study of industrial and vehicular emissions, presenting the fundamental principles of gravitational settling, inertia, filtration, absorption, and combustion applicable to control of various pollutants at their sources with odor and noise control. (3 q.h.)

BIOL 151 Field Botany and Ecology - A study of the structure and life processes of plants, the classification and identification of plants, and the basic principles of plant ecology stressing the environmental affects on the morphology, physiology, and distribution of plants. (3 q.h.)

ENV 215 Wastewater Treatment Techniques - The course is designed to provide the training to permit the student to apply for the State of Ohio Class One Operator Wastewater Exam. The course will emphasize types of treatment and equipment, wastewater hygiene and public health aspects, sewer systems, and budgetry considerations. (4 q.h.)

ENV 225 Stack Gas Sampling and Analysis - The course stresses the basic techniques in source sampling at the stack and the specific analytical techniques required. It also includes the areas of monitor design, isokinetic techniques, and continued vs. periodic sampling techniques. Experiences are gained through practical lab and field work. (3 q.h.)

Technical Electives - Air Option:

ENV 285 Blueprint Interpretation - An introduction to the theory of projection and dimensioning as related to working drawings and blueprints. Development of ability to interpret shape, ENV 285 (Cont'd) - size, position, and functional relationships of structures and mechanisms from blueprints. (3 q.h.)

EE 251 Introduction to Electricity/Electronics - A study of the fundamentals of the science, the how and why circuits behave as they do and their relationship to common devices. Provides an introduction to electricity/electronics. (3 q.h.)

Technical Electives - Water Option:

ENV 265 Microbiological Techniques - The basic techniques in culturing and identifying microorganisms, with emphasis on the bacteriological techniques used in water quality analysis and the environmental health field. (3 q.h.)

ENV 275 Aquatic Organisms - Identification and classification of common aquatic life from microorganisms to vascular plants and vertebrates; ecological relationships, environmental needs and responses to change, and the use of diversity index and indicator species. (3 q.h.)

* courses are listed in the sequence taken by the student

INSTITUTION: NEW JERSEY INSTITUTE OF TECHNOLOGY

PROGRAM: Interdisciplinary Studies in Environmental Engineering
DEPARTMENT: Interdepartmental
DEGREE: Master of Science (M.S.)

CONTACT: Dr. Eugene Golub
Chairman, Dept. of Civil and Environmental Engineering
New Jersey Institute of Technology
323 High Street
Newark, New Jersey 07102
(201) 645-5321

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Because of the need for interdisciplinary approaches to environmental problems, New Jersey Institute of Technology offers a program for students of various backgrounds and interests. The program began four years ago and is offered in addition to an environmental option in civil engineering.

Program administration is accomplished by the Environmental Engineering Committee, an inter-departmental faculty group. Five specializations are offered in the program: industrial waste, pollution control, water resources and water treatment, municipal waste treatment, air pollution control, and solid waste management. Students follow a curriculum approved by a faculty advisor and take courses offered by various departments, primarily civil and environmental engineering, chemical engineering, and mechanical engineering.

Support facilities include the laboratories of the various engineering departments.

PROGRAM REQUIREMENTS

Admission to the program requires an undergraduate degree in engineering, normally from an ECPD addredited Program. It is also recommended that the applicant take the aptitude test and advanced portions of the Graduate Record Examination.

For the M.S. degree, each student must complete eighteen credits of specialization, twelve credits of electives including six credits outside the department of specialization, and a thesis. Each student must also take the following courses: environmental chemistry and legal aspects in environmental engineering.

A student may select courses, with the assistance of the faculty advisor, to fulfill the specialization and elective requirements. The student normally selects courses recommended for one of the five specializations. He can, however, select courses in more than one specialization or from other departments, in line with his career objectives and prior preparation.

CURRENT FACULTY, STUDENTS, GRADUATES

There are currently a total of ten faculty members, all full-time, participating in the program. They divide their time equally between teaching and research. Research is normally performed in the department of the faculty member involved and funding is provided primarily through EPA research grants and the New Jersey Department of Environmental Protection.

A large majority of the students in the program, about 96 percent, come from New Jersey. Little direct recruiting is done for the program and most students become aware of it through other students or faculty. Current sources of student financial support include teaching assistantships, research assistantships, and fellowships.

Although no formal follow-up is done on program graduates, officials indicated that most find employment within the private sector. Jobs are usually found through individual contact by the student or faculty members or through the school's placement service.

PROGRAM PROJECTIONS

Program officials see a need for expansion of the curriculum and in number of students, but feel it is unlikely that this will occur in the near future because of financial reasons.

COURSE DESCRIPTION (SELECTED)

ChE 685 Unit Operations for Industrial Waste Treatment - A course which introduces the student to basic concepts of unit operations which are applicable to the treatment of industrial effluent streams and for municipal waste water advanced treatment. (3 s.h.)

ChE 686 Industrial Waste and Control - The industrial processes and the resulting waste problems associated with key industries are examined. (3 s.h.)

EnE 560 Environmental Chemistry - Basic physical and chemical principles applicable to environmental and sanitary engineering are presented and amplified in the laboratory. (3 s.h.)

EnE 660 Introduction to Solid Waste Porblems - An introductory course in solid waste disposal which covers industrial and urban sources of solid waste and the conventional methods of disposal of these wastes. (3 s.h.)

EnE 663 Pollution: Chemistry and Ecology - This course considers the nature and effects of pollution as it relates to air, water, and soil, and the inhabitants of these areas. Pollution prevention and current pollution research is studied. (3 s.h.)

EnE 668 Air Pollution Control - The nature of the air pollution problem, its effect on the public at large, and the present legal and engineering controls used to combat the problem are considered. (3 s.h.)

EnE 671 Environmental Impact Analysis - Overview of environmental problems, federal and state standards, methodology for developing impact statements, case studies based on recent experience, basis for assessment and decision-making. (3 s.h.)

EM 631 Legal Aspects in Environmental Engineering - A study of the power of the federal, state, local governments and international law in pollution control of air, water and solid wastes. (3 s.h.)

ME 660 Noise Control - A study of engineering methods for reducing noise pollution including reduction of intensity at the source, limitation of transmission paths and absorption; applications to structures, machinery, ground transportation, and aircraft; and noise measurement. (3 s.h.)

ME 661 Thermal Pollution of Water and Air - Study of sources and processes causing thermal pollution and their effects on the environment; study of heat exchange mechanisms between water and air with emphasis on thermal pollution of rivers, streams, lakes and reservoirs; design of cooling ponds and towers; and use of instruments and techniques in thermal pollution control. (3 s.h.)

ME 662 Air Pollution Control and Design - An investigation of the techniques utilized for the solution of air pollution problems. (3 s.h.)

INSTITUTION: NORTH CAROLINA STATE UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Civil Engineering (M.S.)
Master of Civil Engineering (M.C.E.)
Doctor of Philosophy (Ph.D.)

CONTACT: Professor Charles Smallwood, Jr.
Professor of Civil Engineering
Department of Civil Engineering
North Carolina State University
Raleigh, North Carolina 27611
(919) 737-2331

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Civil Engineering at North Carolina State University is one of the largest in the United States, with a current enrollment of over one thousand, including both undergraduate and graduate students. Environmental Engineering is a graduate program under the administration of the Civil Engineering Department, offering three degrees: the Master of Science in Civil Engineering (M.S.), the Master of Civil Engineering (M.C.E.), and the Doctor of Philosophy (Ph.D.). The M.C.E. program is accredited by the Engineers' Council for Professional Development. The undergraduate civil engineering program began in 1888; graduate programs began in 1954. Graduates of the masters programs are qualified for employment as sanitary/environmental engineers in governmental agencies, industries, and consulting engineering firms. Ph.D. graduates are also qualified for these positions, as well as for research and teaching positions in colleges and universities.

The Sanitary Engineering Laboratories contain over three thousand square feet of space. The library contains over 600,000 volumes of scientific and technological material. Computer facilities are available, as is a MW PULSTAR nuclear reactor. Being installed, under a grant from the U.S. Environmental Protection Agency, is a fifty pound per hour fluidized bed coal gasification unit.

Faculty and students in environmental engineering carry out a variety of research projects that are environmentally related. Current sponsored areas of research include the development of a hydrodynamic and water quality model for the Chowan River Estuary, measurement of rural non-point source pollution, the effect of ocean outfalls on coastal waters, and the use of pure oxygen in the treatment of industrial wastewaters. Ph.D. dissertations and master's theses cover an array of related topics. The availability of the fluidized bed coal gasification unit will provide opportunities for special projects and thesis research that otherwise might not be available. Typical projects may include material balances around the unit to determine the quantities of the waste streams, effects of liquid waste on stream life, and the assessment of the effects of different treatment schemes.

PROGRAM REQUIREMENTS

The M.C.E. degree is available only to students holding an ECPD-accredited bachelor's degree in Civil Engineering. This is a non-thesis, design-oriented degree which does require an independent study or project report. The M.S. degree can be obtained by students holding a bachelor's degree in any field of engineering, or by students having degrees in other disciplines who correct any deficiencies in mathematics, the basic sciences, and the engineering sciences. Students may select the M.S. with thesis or the M.S. without thesis option. In all cases, the master's degrees require a minimum of thirty semester hours of credit. The programs are individually tailored to meet the needs and desires of the graduate students. However, five courses are considered to be core, and are required of all students in Environmental Engineering.

Program administrators consider the doctorate degree to symbolize the ability of the recipient to undertake original research and scholarly work at the highest levels without supervision. The degree is not granted simply upon completion of a stated amount of course work, but rather upon demonstration by the student of a comprehensive knowledge and high attainment in scholarship in a specialized field of study. The student must demonstrate this ability by writing a dissertation that reports the results of an original investigation, and by passing a series of comprehensive examinations on the field of specialization and related areas of knowledge.

Every student must carry a minor area of concentration. Normally, a minor consists of one-third of a person's required hours at the master's and Ph.D. level. Students with majors in other disciplines such as wood and paper science, textile chemistry, and food science may also carry a minor in environmental engineering at the graduate level.

CURRENT FACULTY, STUDENTS, GRADUATES

Eight faculty members of the Department of Civil Engineering contribute to the Environmental Engineering program. Their efforts are estimated at 70 percent teaching and 30 percent research. Six of these faculty members work full-time with this program.

Twenty-two students are currently majoring in Environmental Engineering, and twenty are minoring in this field. One student majoring in in the field is sponsored under a training grant, five are supported under research assistantships, and the remainder are self-supporting. The number graduating with master's degrees in Environmental Engineering has decreased from eleven in 1974-1975 to eight in 1976-1977; this is attributed to the decline of training grants available. The annual number of those receiving the Ph.D. in Environmental Engineering has averaged two to three.

Follow-up data on graduates indicate that of twenty-nine graduates since 1974, eleven have gone to governmental agencies, eleven to consulting engineering firms, and two to private industry. Additionally, two have become instructors, two have returned to their home countries, and one has continued his/her schooling. All have remained within the field of environmental engineering. It is noteworthy that the food scientists, textile chemists, and pulp and paper engineers who minor in pollution control and abatement are often first to find employment because of their value in both production and control in manufacturing activities.

PROGRAM PROJECTIONS

Because of the lack of training grants, and a school-wide enrollment quota, administrators anticipate that the number of students in Environmental Engineering will remain stable or slightly decline. Plans are underway, however, to expand the curriculum with three new areas of concentration. The first area relates to the environmental impact of energy systems. Two traineeships are being requested from the U.S. Department of Energy; these students would take the Environmental Engineering core and carry a strong minor with energy-related courses. All would be required to complete a major project or thesis in this area. Also being considered is the development of a subprogram in urban hydrology and non-point sources. Students would also have the option of concentrating in this area within the Environmental Engineering program. Finally, the department may coordinate with the Department of Economics and Business in offering a stronger concentration in management and economics in environmental engineering. Graduates with this concentration would be qualified to manage county-level waste management agencies or to manage water or wastewater treatment plants.

ADDITIONAL INFORMATION

Program officials have emphasized that sanitary/environmental engineers, in their employment endeavors, are constantly concerned with energy recovery and/or conversion. For example, sludge dewatering is a major source of energy consumption and is facilitated by the anaerobic digestion process, which may recover energy from methane production. Another example is the backwash process in both water and waste treatment. The high rates of pumping require large amounts of energy, which may be minimized by careful scheduling. In addition, a large number of civil engineers are employed in the planning, design, construction and operation of hydroelectric, fossil, and nuclear power plants.

COURSE DESCRIPTION

Core Courses:

CE (BAE, MB) 570 Sanitary Microbiology - Fundamental aspects of microbiology and biochemistry are presented and related to problems of stream pollution, refuse disposal and biological treatment. Laboratory exercises present basic microbiological techniques and illustrate from a chemical viewpoint some of the basic microbial aspects of waste disposal. (3 s.h.)

CE 571 Theory of Water and Waste Treatment - Study of the basic physical and chemical processes underlying water and waste treatment, including mass transfer, equilibria, kinetics. (3 s.h.)

CE 572 Design of Water and Wastewater Facilities - Theory and design of water and wastewater treatment plants. (3 s.h.)

CE 573 Unit Operations and Processes in Waste Treatment - Unit operations and processes in water and wastes engineering, including sedimentation, thickening, chemical coagulation, vacuum filtration, carbon absorption, biological treatment, and special projects. (3 s.h.)

CE 672 Advanced Water and Waste Treatment: Principles and Design - Theory and design of physiochemical processes used to control phosphorus, nitrogen, trace metals, toxic organic substances in water. (4 s.h.)

Other Environmental Engineering Graduate Courses:

CE 506 Municipal Engineering Projects - Special problems relating to public works, public utilities, urban planning and city engineering. (3 s.h.)

CE 543 Hydraulics of Ground Water - Principles of ground water hydraulics; theory of flow through idealized porous media; the flow net solution; seepage and well problems. (3 s.h.)

CE (NE) 574 Environmental Consequences of Nuclear Power - An examination of the environmental consequences resulting from the siting, construction and operation of nuclear power plants as well as the environmental consequences of alternatives to nuclear power. Fuel sources; fuel reprocessing; sources and treatment of solid, liquid, gaseous wastes; the costs of minimizing wastes and the effects of rejected heat; beneficial uses of rejected heat; pertinent regulations are examined. (3 s.h.)

CE 575 Civil Engineering Systems - An examination of civil engineering systems and their design optimization. Systems include water resources engineering, structural engineering, transportation engineering, and construction. (3 s.h.)

CE 576 Atmospheric Pollution - A survey of the problem of atmospheric pollution. Pollutant sources; effects on man and other animals, vegetation, materials and visibility; meteorological factors, air sampling; control devices; air quality and emission standards; legal economic and administrative aspects. (3 s.h.)

CE 580 Flow in Open Channels - The theory and applications of flow in open channels, including dimensional analysis, momentum-energy principle, gradually varied flow, high-velocity flow, energy dissipators, spillways, waves, channel transitions and model studies. (3 s.h.)

CE (MAS) 581 Introduction to Oceanographic Engineering - A rigorous treatment of the engineering aspects of physical oceanography. The theory for the propagation of waves, methods of wave forecasting and the analysis of wave spectra. The applications of physical oceanography to the design of marine and coastal installations. (3 s.h.)

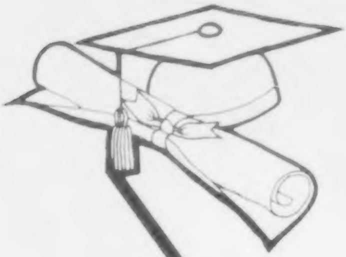
CE 598 Civil Engineering Projects - Special projects in some phase of civil engineering. (1-6 s.h.)

CE 644 Ground Water Engineering - Ground water problems as related to engineering works, ground water circulation and inventories, subsidence of the ground and its evaluation due to pumping, method of images applied to water circulation of wastes and salt water encroachment in coastal aquifers, transient flow systems in wells and earth dams and embankments. Leakage problems, practical ground water problems and their analysis by computers and electrical models. The legal aspects of ground water conservation and the implied technical and engineering phases. (3 s.h.)

CE 671 Advanced Water Management Systems - The application of systems analysis methods to the design, analysis and management of water and waste systems. (4 s.h.)

CE 673 Industrial Water Supply and Waste Disposal - Water requirements of industry and the disposal of industrial wastes. (3 s.h.)

CE 674 Stream Sanitation - Biological, chemical and hydrological factors that affect stream sanitation and stream use. (3 s.h.)



Post Secondary Education Profile

U S DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
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COMPOSITE I (cont'd)

(Environmental Engineering/Health)

Phase II

Of A National Environmental/Energy Workforce Assessment

Conducted by:

NATIONAL FIELD RESEARCH CENTER, INC.
P. O. Box 287
Iowa City, Iowa 52240

SE 025 199

NATIONAL ENVIRONMENTAL/ENERGY WORKFORCE ASSESSMENT

PHASE II

POST-SECONDARY EDUCATION PROFILE

COMPOSITE I

(Environmental Engineering/Health)

(con't.)

Conducted by:

NATIONAL FIELD RESEARCH CENTER, INC.

Under Grant from:

UNITED STATES

ENVIRONMENTAL PROTECTION AGENCY

Grant #T900591

1978

This document has been reviewed by the Environmental Protection Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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INTRODUCTORY NOTE

The National Environmental/Energy Workforce Assessment: Post-Secondary Education Profile was conducted by National Field Research Center, Inc. with main offices in Iowa City, Iowa. The following personnel have had primary responsibility for the development of the project report.

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VOLUME I (cont'd)

Envrionmental Engineering/Health - Volume I (cont'd) contains summaries of those post-secondary training programs which, due to space limitations, could not be included in Volume I. Appendices relevant to both volumes are included in Volume I (cont'd). These Engineering/Health volumes represent a single set and are not intended to be distributed or read as independent volumes.

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INSTITUTION: OHIO STATE UNIVERSITY

PROGRAM: Agricultural Engineering*

DEPARTMENT: Agricultural Engineering

DEGREE: Bachelor of Science
Master of Science
Doctor of Philosophy

CONTACT: Dr. Gordon Nelson, Chairman
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PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

In existence since 1970, pollution-related courses in Agricultural Engineering at Ohio State University originally emphasized engineering and livestock waste. Now, however, the focus is expanding to include sediment and municipal waste and sludge pollution. Three degree programs are available in Agricultural Engineering: B.S., M.S., and Ph.D. Students enrolled in these programs learn "to design, develop, and test new or improved agricultural machines; to devise new ways of processing agricultural products on the farm and in food plants; new engineering methods for soil and water resource conservation; and structures and systems to create optimum environments for animal or plant growth." Areas of emphasis in graduate work include: livestock waste engineering, hydrology of non-point pollution sources; odor identification and control; livestock environment analysis and modification; plant environment engineering; soil and water engineering; systems for land application of municipal sewage sludge; and food processing plant waste engineering."

Research facilities include the North Appalachian Experimental Watershed at Coshocton, Ohio, where studies on "agricultural watershed hydrology in relation to environmental effects" are conducted; and the Pioneering Research Laboratory at the Ohio Agricultural Research and Development Center at Wooster, Ohio, that is "engaged in basic studies of aerosol and gaseous constituent transport in relation to the environment of plant canopies." The Department maintains a facility for "laboratory studies of livestock waste treatment at Ives Hall" and "an experimental lagooning installation for storing liquid livestock waste for use in irrigation, and experimental disposal field."

With the Ohio Extension Service, the Department conducts continuing education courses and workshops for professionals and paraprofessionals in and out of the state. Topics have included domestic and residential sewage disposal, wastewater, and drainage. Staff personnel are currently in the process of setting up a cooperative work program for students who until this time were dependent on summer jobs for professional experience during their schooling.

Federal and state monies have supported recent pollution-related research in the Department. The Hatch Act appropriation has given funding to the Agricultural Experiment Station for study on water quality as affected by crop culture and animal occupancy. Special monies from the State of Ohio have supported investigations of cost/effective livestock management systems to control pollution and of the effect of pasturing on non-point surface runoff. A recently submitted proposal to the Environmental Protection Agency asks for funding of an interdisciplinary project involving government, university, and experiment station resources in demonstrating the best management systems for disposal of animal wastes.

PROGRAM REQUIREMENTS

Students must complete 215 quarter hours (40 in Agricultural Engineering, 16 Technical Electives) to obtain the B.S. degree. A minimum master's degree program (45 hours with thesis, 50 hours without thesis) must contain at least "15 hours of advanced basic science, such as mathematics, physics, or biology," "6 hours of 500-level or higher mathematics, and one graduate-level three-course sequence in the area of specialization." A doctoral candidate "must offer in-depth preparation in a recognized area of specialization related to agricultural engineering, plus supporting work in research tools and concepts such as mathematics, statistics, physics, engineering sciences, and biological sciences to enable the student to plan research and to analyze and interpret research results."

CURRENT FACULTY, STUDENTS, GRADUATES

Approximately twelve faculty members (in Columbus or Wooster) devote some portion of their time to environmental concerns. Their areas of expertise include soil and water management, pesticide application, environmental interaction modeling, watershed hydrology, benefit appraisal and assessment procedure to implement projects under Ohio drainage laws, rural domestic and agricultural uses of water, effects of environmental stress on swine and other farm animals, water quality, agricultural pollution control, waste utilization, and waste management.

There are eighty undergraduates and eight M.S. and fourteen Ph.D. candidates in the program at present. Numbers of graduates annually have been stable over the last few years (18-20 B.S., 3 M.S., and 4 Ph.D.). Eighty percent of the graduate students receive financial support from appropriated monies or industrial grants; the remainder are self-supporting or in the case of any foreign students, sometimes supported by home governments or universities.

Employment possibilities are extensive with approximately 15% of the B.S. and M.S. students pursuing advanced degrees, 55% entering private sector jobs, and 30% entering industry. Ph.D. graduates seek employment in universities with Agricultural Engineering Departments. Undergraduates "find employment as engineers with agencies such as: Soil Conservation Service, Environmental Protection Agency (federal and state), consulting engineering firms, and manufacturers of equipment and systems for agricultural environmental and pollution-related applications." Individuals with advanced degrees are employed by the U.S. Department of Agriculture, Environmental Protection Agency, WHO-UN, consulting engineering firms, and manufacturers of environmental systems and equipment.

PROGRAM PROJECTIONS

The Agricultural Engineering program at Ohio State adapts to changing social problems and crises. Currently, training has reflected a response to the environmental crisis; necessary future responses to energy, food, and water emergencies will undoubtedly expand and modify the curriculum. No faculty or staff increases are anticipated, and student enrollment should remain stable or increase.

COURSE DESCRIPTION**

Agricultural Engineering:

535 Utilization of Energy in Agriculture - Study of motive and stationary power needs of agriculture, mechanics of traction, characteristics of power sources, morphology of off-the-road vehicle design. (U G 4 q.h.)

543 Engineering Soil-Water Management - Engineering design of drainage, irrigation, and erosion control systems for optimum crop growth, environment, and related water storage structures. (U G 5 q.h.)

645 Environmental Engineering of Agricultural Structures - Functional requirements and principles involved in housing animals and crops; analysis of factors and properties affecting energy exchanges with the environment. (U G 4 q.h.)

657 Soil Machine Dynamics in Plant Environment - Soil dynamics in relation to plant environment and agricultural machine design. (U G 4 q.h.)

714 Environmental Pollution Abatement - Problems, philosophies, and methods of pollution abatement in the total environment; quantitative approaches to waste management in air, water, and land systems. (U G 5 q.h.)

750 Design of Waste Management Systems - Application of bioengineering principles of pollution control in the design of management systems for wastes from food and fiber production, storage, and processing operations. (U G 3 q.h.)

877 Drainage Engineering - Principles of water movement to subsurface drains including depth and spacing; frequency analysis of drainage

877 (Cont'd) - flow; hydrologic characteristics of drainage systems; drainage requirements of crops. (G 3 q.h.)

*Sources: The Ohio State University Bulletin (Graduate School, College of Engineering, Course Offerings) 1976-78; Environmental Programs and Activities at The Ohio State University (September 1976).

**U = undergraduate level course; G = graduate level course

INSTITUTION: OHIO STATE UNIVERSITY

PROGRAM: Civil Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science, Hydraulics Engineering-Hydrology (B.S.); Bachelor of Science, Sanitary Engineering (B.S.); Master of Science & Doctor of Philosophy, Environmental & Water Chemistry (M.S., Ph.D.); Master of Science & Doctor of Philosophy, Hydrology & Hydraulic Engineering (M.S., Ph.D.); Master of Science & Doctor of Philosophy, Sanitary & Environmental Engineering (M.S., Ph.D.); Master of Science, Civil Engineering & Public Administration (M.S.)-Public Works Administration/Environmental & Engineering Management; Doctor of Philosophy, Civil Engineering (Ph.D.)

CONTACT: Dr. Otis J. Sproul, Chairman
Department of Civil Engineering
Ohio State University
470 Hitchcock Hall
Columbus, Ohio 43210
(614) 422-2771

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The current College of Engineering Catalogue summarizes well the undergraduate Civil Engineering curriculum and its environmentally related program options. It notes:

> The future civil engineer needs to be versed in a number of disciplines in order to cope with the various problems he will encounter in the practice of his profession. In the civil engineering curriculum at The Ohio State University, the student studies fundamental methematics and science, on which much of engineering is based; social sciences and humanities, to broaden his perspective and to prepare him for professional interaction with people; a core of basic civil engineering subject areas, including courses in transportation, structures, water resources, materials, and applied mathematics; and a personally tailored group of electives in the student's selected area of concentration.

Major elective options available to students in the undergraduate Civil Engineering program include:

Sanitary Engineering--distribution and collection, design of treatment facilities
Hydraulic Engineering and Hydrology--hydraulics, hydrology, fluid mechanics, water resource systems analysis
Environmental and Engineering Surveys--surveying, photogrammetry, remote sensing

The graduate level offerings in the department are likewise varied. To obtain a Master of Science or Doctor of Philosophy degree in Civil Engineering, students must complete a minimum number of courses in an area of specialization; among these are areas of emphasis in Environmental and Water Chemistry, Hydrology and Hydraulic Engineering, and Sanitary and Environmental Engineering. A dual M.S. degree program with the Department of Public Works Administration is designed for those persons seeking administrative and technical positions with state and federal environmental protection agencies and private consulting engineering companies.

Students in these Civil Engineering programs utilize numerous facilities and laboratories on the Ohio State University campus. With the City of Columbus, the Water Resources Center is now building some pilot-plant equipment to be used in water treatability research. An Engineering Experiment station administers sponsored research and service programs throughout the College of Engineering, and in addition to the Water Resources Center, maintains a 10 K.W. Nuclear Reactor, and a Transportation Research Center. The CLEAR (Center for Lake Erie Area Research) project maintains a laboratory at Put-in-Bay on Lake Erie which is open to OSU students and staff. The Department of Civil Engineering also sponsors short courses for practitioners on such topics as design procedures, environmental impact statements, small dam design, and hydrology of lakes.

Currently faculty research projects are funded by both the Ohio and the U.S. Environmental Protection Agencies, Office of Water Research and Technology, Engineering Experiment Station, International Joint Commission, City of Columbus, Battelle Memorial Institute, the U.S. Army Corps of Engineers, and the U.S. Army Research and Development Command. Topics and/or areas of interest include: gas movements in sanitary landfills; fluid mechanics laboratory apparatus; prediction of nutrient, oxygen, plankton, and sludge distributions in a stratified euthropic lake; Lake Erie shore erosion damage; mechanism of soil erosion by runoff; predictive and pollution abatement modeling for mine drainage; mechanism of ozone inactivation of waterborne viruses, recovery of ultrafine coal particles by microflotation; integration and synthesis of watershed studies on the effects of land use on pollutant loadings to Lake Erie; assessment impacts of energy conversion on the environment of the Ohio River Basin; inactivation of cysts with cynauric acid compounds; and elimination of filamentous blue-green algae at the Southerly Sewage Treatment Plant (Columbus).

PROGRAM REQUIREMENTS

To complete the B.S. degree program in Civil Engineering, a student must obtain a minimum of 200 quarter hours of credit. In addition to a set of core courses, undergraduates must take 31 hours in Major Option and Professional Electives in the third and fourth years. Major options (e.g., sanitary engineering) include specific required courses (approximately 14 hours) and recommended courses for Professional Electives. It is possible to count the required courses in one Major Option as Professional Electives in another Major Option. In exceptional cases, a student may work with the faculty advisor to design an honors program for the entire 31 required credit hours.

A baccalaureate degree in Civil Engineering for an Engineering Council for Professional Development accredited curriculum satisfies the admission requirements for graduate study. Applicants with other baccalaureate degrees in engineering, in allied fields, or from non-accredited curricula will be considered for admission in accordance with the College of Engineering admission policy guidelines. Such students may be required to take additional courses depending upon their preparation and objectives.

To obtain an M.S. degree in Civil Engineering, students must complete a minimum total of 45 graduate credit hours of coursework and 9 graduate credit hours of thesis. (A non-thesis, 50 graduate-credit hour plan is permitted only in exceptional cases of wide professional experience.) The Ph.D. in Civil Engineering requires 135 graduate hours beyond the baccalaureate (90 hours of coursework and 45 hours of dissertation). Individual options at the doctoral level require certain components of courses and levels.

The dual-master's degree program offered by the Departments of Civil Engineering and Public Works Administration awards candidates the degrees of Master of Science in Civil Engineering and Master of Public Administration upon completion of the program. Students are expected to complete a minimum of 78 hours in both departments. A thesis is not required, but it is expected that an original Policy Paper will be completed during the second year of the program as an integral part of the Policy Problems Seminars (PA 850 and 851). This paper, in addition to fulfilling the course requirement, must be reviewed for approval by a faculty member of the Department of Civil Engineering and the Division of Public Administration. Summer internships are encouraged in this dual program.

CURRENT FACULTY, STUDENTS, GRADUATES

There are seven faculty members in Civil Engineering involved with the programs included in this summary, six of whom split their time evenly between teaching and research, one who is a full-time administrator but devotes 20-30 percent of his time to research, and one who is one-half time in administration but spends 20 percent of his time on research. In the Hydraulics/Hydrology, Sanitary Engineering, and Environmental Engineering Major Options, there are 32 seniors currently enrolled. In the relevant graduate study areas, there are 21 M.S. and five Ph.D. candidates. On the average, the program awards 32 B.S., six to eight M.S. and one Ph.D. degree. Undergraduate and graduate enrollment levels are increasing. Graduates are employed in the private sector (55 percent) and government (45 percent), and the placement record of the department is excellent. Standard grant programs exist for undergraduates, while financial aid to graduate students consists of research grant support and teaching assistantships (80-85 percent) and outside employment or home government subsidies (15-20 percent).

PROGRAM PROJECTIONS

The long-range goals of the Civil Engineering program include increased curriculum offerings and research in remote sensing, hydrology and hydromechanics - all key environmental areas. While the current program is expected to continue, two faculty members (in environmental survey, hydromechanics and hydrology) must be added and laboratory space and support expanded if the status quo is to be maintained. New staff and facilities would vastly increase the capabilities of the department to prepare students for the major, regional environmental questions they must face and answer. Change in environmental programs generally will, in all probability, come in emphasis and not in greater student enrollments.

COURSE DESCRIPTION (SELECTED)*

Civil Engineering:

410 Environmental Pollution and Control - Environmental pollution: the causes and control of air, water, and land pollution in relation to their effects on health, aesthetics, economics and ecology. (U 3 q.h.)

460 Professional Aspects of Civil Engineering - Structure of the civil engineering profession; interaction of civil engineers with the education process, their clients, other professions and the public. (U 1 q.h.)

518 Environmental Quality - Introduction to environmental quality; air pollution; solid waste disposal; water quality and treatment; wastewater characteristics and treatment. (U G 4 q.h.)

519 Applied Hydraulics - Applied fluid mechanics including pressure probes, open and closed conduit flow measurement and devices; tubo-machinery, homologous units, characteristic curves; water hammer; surge; conduits; laboratory experiments. (U G 3 q.h.)

521 Water Distribution and Wastewater Collection - Design of water supply collection, transmission and distribution systems; design of sewage and storm water collection and disposal systems.(UG3qh)

540 Civil Engineering Systems - Basic concepts and methods of systems engineering and application to civil engineering problems in transportation and water resources planning, structural design, and construction management. (U G 4 q.h.)

576 Civil Engineering Economics and Planning - Engineering economics and theories of planning applied to private and public civil works. (U G 4 q.h.)

603 Remote Sensing of Environment - The energies of the natural and cultural environment; current remote sensing systems and case histories of applications in measuring the environment. (U G 4 q.h.)

610 Analysis of Natural and Polluted Waters - A laboratory study of the measurement and interpretation of water quality indices and pollution, parameters including BOD, COD, alkalinity, nutrients, pH, and heavy metals. (U G 4 q.h.)

613 Applied Hydrology - Hydrologic cycle, meteorology, streamflow, evapotranspiration, hydrographs, runoff relations, runoff hydrographs, groundwater, unit hydrographs, flood routing, frequency and duration studies, and application of hydrologic techniques. (U G 4 q.h.)

614 Transport Phenonmena in Water Resources Engineering - Momentum mass and energy transfer; dimensional analysis; laminar and turbulent transport and mixing; techniques applied to water environment; contaminated transport and hydrodynamics, stratification, and outfall mixing. (U G 4 q.h.)

618 Design of Treatment Facilities - Selection and design of processes for the purification of drinking water and the treatment of wastewaters. (U G 4 q.h.)

624 Coastal and Ocean Engineering - Elementary linear and nonlinear wave theory; wave forecasting spectra; forces on fixed submerged structures; beach processes, littoral drift and sediment transport; shore line protection; coastal outfalls and intakes. (U G 4 q.h.)

677 Noise, Pollution and Safety Aspects of Transportation Systems - Vehicle noise and emissions as affected by operating characteristics; noise measurement and abatement techniques; air quality legislation, air pollution; traffic accident analysis. (U G 4 q.h.)

713 Environmental Engineering Measurements - The application of advanced physical and chemical measurement and calculation techniques to environmental engineering problems. (U G 4 q.h.)

714 Environmental Pollution Abatement - Problems, philosophies, principles, and methods of pollution abatement in the total environment; quantitative approaches to waste management in air, water, and land systems. (U G 5 q.h.)

715 Water Resource Systems: Water Quantity - Planning, design, and operation of reservoirs for single and multiple-purpose use, flood estimation and management alternatives, conjunctive use of ground and surface waters. (U G 4 q.h.)

717 Industrial and Municipal Solid Waste Disposal - Characterization and sources of solid waste; solid waste management; collection systems; processing and disposal; and recycle. (U G 3 q.h.)

719 Stream Sanitation - A study of stream quality standards; effluent standards; and the assimilative capacity of natural water bodies. (U G 4 q.h.)

720 Water Resource Systems: Water Quality - Mathematical modeling of conservative and non-conservative pollutants in aquifers, streams, lakes, estuaries and coastal waters and methods for obtaining least cost correction measures. (U G 4 q.h.)

721 Design of Hydraulic Structures - Basic engineering economic studies, water laws design concepts, reservoir engineering, river training, spillways and energy dissipators; irrigation structures, and channel transition design. (U G 4 q.h.)

724 Dynamic Oceanography - Physical and chemical properties of pure and sea water; global energy balance, governing equations, ocean statics, circulation features, stratification, chloride and pollutant distribution; tide prediction and measurement. (U G 4 q.h.)

755 Solid Waste as a Construction Material - Solid waste material characteristics, production and availability; physical-chemical nature; application in soil stabilization, embankment construction, asphaltic pavements and concrete mixtures. (U G 3 q.h.)

795 Seminar in Civil Engineering - Lectures and discussions of current topics related to civil engineering presented by faculty, students, and guest speakers: term paper required. Repeatable to maximum of 3 credit hours. (U G 1 q.h.)

804 Water Resources Engineering Applications of Remote Sensing - Principles and techniques of using remote sensing for acquisition of data in water resources engineering projects and water quality investigations. (G 5 q.h.)

810 Physical Water and Wastewater Treatment Processes - Principles and design of physical processes for water and wastewater treatment including screening, sedimentation, mixing, floatation, and filtration. (G 3 q.h.)

811 Biological Wastewater Treatment Processes - Principles and design of biological processes for wastewater treatment (G 5 q.h.)

812 Chemical and Advanced Wastewater Treatment Processes - Principles of physical-chemical treatment processes for water and wastewater, including coagulation, softening, absorption, nutrient removal and disinfection. (G 5 q.h.)

814 Industrial Wastewater Treatment - Principles of industrial wastewater treatment including wastewater surveys; flow reduction, and segragation and equalization; batch and continuous treatment; instrumentation, and treatment processes. (G 3 q.h.)

820 Advanced Hydrology - Advanced analysis of classical concepts; study of new techniques and concepts developing in modern hydrology; written and oral presentations of critical reviews of current literature. (G 5 q.h.)

850 Seepage in Permeable Materials - Analysis of seepage volume and stresses in connection with excavation, dams, wells, slopes, and subsurface drainage; electro-osmosis. (G 4 q.h.)

Agricultural Engineering:

750 Design of Waste Management Systems - Application of bioengineering principles of pollution control in the design of management systems for wastes from food and fiber production, storage, and processing operations. (U G 3 q.h.)

Chemical Engineering:

671 Legal Aspects of Engineering - Basic legal concepts; the administrative processes as exemplified by environmental regulation; patents, trade secrets; selected topics from the viewpoint of the engineer and scientist. (U G 3 q.h.)

771 Air Pollution - Sources of air pollutants, properties of small particles, chemistry of air pollution, dispersion and deposition of air pollutants, and air pollution control. (U G 3 q.h.)

Geography:

530 Conservation of Natural Resources - Philosophy of resource use; appraisal of resource base; costs of resource development and conservation; resource perception, utilization and alternatives. (U G 4 q.h.)

650 Urban Geography - Origin and growth of cities; structure and function of urban centers, their areal expansion, and intertrade center relations, each examined in relation to city planning. (U G 5 q.h.)

Law:

719 Natural Resources - The nature and incidents of public and private interests in water, minerals, oil and gas; conveyancing of natural resources, and mineral, oil and gas leasing. (P 4 q.h.)

732 Environmental Law - Legal problems relating to the living environment; legal problems of conservation of resources such as forest, wildlife, soil and parks. (P 3 q.h.)

Mechanical Engineering:

636 Nuclear Power Plants - A study of the thermal and mechanical design aspects of nuclear power plants and processes. (U G 3 q.h.)

640 Principles of Environmental Control - A study of the principles of the control of environments for human occupation, occupation by other living beings, the operations of mechanical and electrical equipment, and for the storage and processing of materials. (U G 3 q.h.)

Microbiology:

634 Water Microbiology - A basic study of the relationships and influence of aquatic environments on micro-organisms and the effect of microbial metabolic processes on the quality of water. (U G 5 q.h.)

Natural Resources:

600 Natural Resources Problems, Programs, and Policies - Analytical study of contemporary and future problems of natural resources conservation and programs and policies related to their solution. (U G 4 q.h.)

Nuclear Engineering:

505 Introduction to Nuclear Science and Engineering - Discussions of nuclear energy and nuclear radiation; sources, methods of utilization, and projections for future engineering uses. (U G 3 q.h.)

606 Radiological Safety - General principles of radiation, radioactivity, and protection methodology with emphasis on approved operating, handling and waste disposal procedures, also regulations and biological effects. (U G 3 q.h.)

626 Introduction to Nuclear Power - Nuclear power reactors; the economic and technical aspects of the nuclear power industry. (U G 3 q.h.)

*Instructional Level:
U = Undergraduate
G = Graduate
P = Professional

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INSTITUTION: OHIO STATE UNIVERSITY

PROGRAM: Environmental Biology

DEPARTMENT: College of Biological Sciences

DEGREE: Master of Science
Doctor of Philosophy

CONTACT: Dr. Emanuel D. Rudolph, Director
Dr. Sheldon I. Lustick
Environmental Biology Program
College of Biological Sciences
Ohio State University
1735 Neil Avenue
Columbus, Ohio 43210 (614) 422-5306

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Biology program at Ohio State University, according to its 1976-77 Annual Report, is designed "to provide educational and research opportunities for a limited number of graduate students who desire a background in biological understanding as it relates particularly to problems concerning the environments of organisms and biological systems." Students may pursue M.S. or Ph.D. degrees and construct their plans of study from a list of environmentally-related courses offered across the campus. The curriculum is broadly oriented insuring that students receive both basic and applied science training and flexible enough to permit a varied scope depending on one's career goals.

Research opportunities are diverse. A list of current or recent projects would include: the ecology of aquatic insects, factors affecting lake eutrophication, the measurement of fitness in natural communities, the physiological and biochemical ecology of microorganisms, analysis and dynamics of terrestrial ecosystems, the physiology of environmental stress, the evolution of fitness in animal populations, the productivity and population biology of aquatic ecosystems, and the ecology and phytogeography of polar regions. Field research may encompass "a variety of local habitats, or range as far as the tropics and polar regions."

Facilities available to students and faculty include laboratories on islands in Lake Erie; the Neotoma Bioclimatic Laboratory equipped with environmental sensing devices; the Institute of Polar Studies providing a unique access to research in polar regions; the Ohio Cooperative Wildlife Research Unit with several natural areas and research stations, vehicles, and laboratory facilities (e.g., gas chromatographs, liquid scintillation spectrometer, atomic absorption spectrometer, and a pulse height analyzer); the Ohio Cooperative Fisheries Unit; and the

Acarology Lab supporting both the applied and theoretical study of acarine biology.

The Environmental Biology Program co-sponsors an annual conference on an environmental topic with the Ecology Committee of the Ohio Academy of Sciences, the Battelle Columbus Laboratories, and the Ohio Biological Survey. Recent symposia have centered on the topics "Environmental Impact Assessment: the Role of Biologists" and "Stress Effects on Natural Ecosystems." Both faculty and students are encouraged to take an active part in these proceedings.

The program has received funding from within and outside the University. Sources of support include the National Science Foundation, Environmental Protection Agency, Department of the Interior, Atomic Energy Commission, American Electric Power Service Company and CLEAR (Center for Lake Erie Area Research).

PROGRAM REQUIREMENTS

Applicants to the Environmental Biology Program should have either an undergraduate major in the biological sciences or a major in one of the physical sciences with a strong foundation in the biological sciences. Basic competence in chemistry, physics, and mathematics is required; and students with a deficiency may be admitted on probation until the deficiency is removed.

Although M.S. and Ph.D. degrees are offered, capable students are encouraged to pursue the doctoral degree. Candidates for the master's degree have two options: thesis (45 credit hours of coursework) or non-thesis (50 credit hours of coursework). Most studies in the Environmental Biology program require a thesis, with only unusual cases of specialized training being substituted for a thesis. At least two quarters (for M.S.) and five quarters (for Ph.D.) of participation in the Environmental Biology Seminar are also required. All courses, except for the Environmental Biology Seminar, are decided upon by the student and advisor and drawn from a master list of relevant O.S.U. courses. Students must demonstrate a comprehensive knowledge of one modern foreign language or a meaningful substitute (e.g., computer language) as determined by the student's advisory committee.

CURRENT FACULTY, STUDENTS, GRADUATES

The interdepartmental nature of the program makes any count of participating faculty in Environmental Biology difficult, but current bulletins indicate 18-20 staff members are primarily involved. There are fourteen Environmental Biology graduate students and an additional 100 undergraduates whose major programs are oriented to ecological studies. Financial support to students includes 2-4 teaching assistantships through the College of Biological Sciences, several research assistantships through faculty grants, two O.S.U. fellowships, and funding from CLEAR.

An average of seven students complete their degrees annually. Employment opportunities include work in government at state and federal levels, drafting environmental impact statements, and teaching. Faculty contend that the broader the range of training, the better the student's chances of getting a job. Though no formal internship program exists at the graduate level, it might make job placement easier.

PROGRAM PROJECTIONS

The stability of the Environmental Biology Program at Ohio State depends on several factors. One, funding is needed to upgrade the program and maintain its breadth. According to faculty personnel, government grants tend to be unfortunately narrow and geared to specific problems rather than to the environmentalist's general field and his/her ability to foresee problems. Without funding, the future is dim. Two, with the majority of graduates seeking applied-science employment, the healthy shift by industry and consulting firms to hire "broad-view," adequately trained students will prove increasingly beneficial. Three, the attraction of society in the early 1970's to environmental education programs waned with the energy crisis in recent years. However, faculty project a renewed concern with the environment when we realize how our strip mining and energy measures are altering it.

COURSE DESCRIPTION

Agricultural Engineering:

543 Engineering Soil-Water Management - Engineering design of drainage, irrigation, and erosion control systems for optimum crop growth, environment, and related water storage structures. (5 q.h.)

645 Environmental Engineering of Agricultural Structures - Functional requirements and principles involved in housing animals and crops; analysis of factors and properties affecting energy exchanges with the environment. (4 q.h.)

714 Environmental Pollution Abatement - Problems, philosophies, and methods of pollution abatement in the total environment; quantitative approaches to waste management in air, water, and land systems. (5 q.h.)

750 Design of Waste Management Systems - Application of bioengineering principles of pollution control in the design of management systems for wastes from food and fiber production, storage, and processing operations. (3 q.h.)

877 Drainage Engineering - Principles of water movement to subsurface drains including depth and spacing; frequency analysis of drainage flow; hydrologic characteristics of drainage systems; drainage requirements of crops. (3 q.h.)

Agricultural Mechanization and Systems:

550 Pollution Control and Waste Utilization - Management and utilization of animal wastes, fertilizers, pesticides, crop residues, milk and food processing and farmstead and urban solid wastes to abate environmental pollution at the urban-rural interface. (3 q.h.)

570 Agricultural and Forest Hydrology - Hydrology of small watersheds as influenced by watershed management practices; water resource development; control of sediment and floods; and water quality conservation. (3 q.h.)

Chemical Engineering:

571 Air Pollution - Sources and dispersion of air pollutants, air pollution control, air quality criteria, emission standards and regulations. (3 q.h.)

714 Environmental Pollution Abatement - Problems, philosophies, principles, and methods of pollution abatement in the total environment; quantitative approaches to waste management in air, water, and land systems. (5 q.h.)

771 Air Pollution - Sources of air pollutants, properties of small particles, chemistry of air pollution, dispersion and deposition of air pollutants, and air pollution control. (3 q.h.)

Civil Engineering:

516 Water Resources Engineering - Pipe systems, introduction to open channel flow, basic hydrology, demographic studies, water supply, and wastewater flows. (4 q.h.)

518 Environmental Quality - Introduction to environmental quality; air pollution; solid waste disposal; water quality and treatment; wastewater characteristics and treatment. (4 q.h.)

521 Water Distribution and Wastewater Collection - Design of water supply collection, transmission and distribution systems; design of sewage and storm water collection and disposal systems. (3 q.h.)

603 Remote Sensing of Environment - The energies of the natural and cultural environment; current remote sensing systems and case histories of applications in measuring the environment. (4 q.h.)

610 Analysis of Natural and Polluted Waters - A laboratory study of the measurement and interpretation of water quality indices and pollution, parameters including BOD, COD, alkalinity, nutrients, pH, and heavy metals. (4 q.h.)

613 Applied Hydrology - Hydrologic cycle, meteorology, streamflow, evapotranspiration, hydrographs, runoff relations, runoff

613 (Cont'd) - hydrographs, groundwater, unit hydrographs, flood routing, frequency and duration studies, and application of hydrologic techniques. (4 q.h.)

618 Design of Treatment Facilities - Selection and design of processes for the purification of drinking water and the treatment of wastewaters. (4 q.h.)

677 Noise, Pollution and Safety Aspects of Transportation Systems - Vehicle noise and emissions as affected by operating characteristics; noise measurement and abatement techniques; air quality legislation, air pollution; traffic accident analysis. (4 q.h.)

714 Environmental Pollution Abatement - Problems, philosophies, principles, and methods of pollution abatement in the total environment; quantitative approaches to waste management in air, water, and land systems. (5 q.h.)

715 Water Resource Systems: Water Quantity - Planning, design, and operation of reservoirs for single and multiple-purpose use, flood estimation and management alternatives, conjunctive use of ground and surface water. (4 q.h.)

717 Industrial and Municipal Solid Waste Disposal - Characterization and sources of solid wastes; solid waste management; collection systems; processing; disposal; and recycle. (3 q.h.)

719 Stream Sanitation - A study of stream quality standards; effluent standards; and the assimilative capacity of natural water bodies. (4 q.h.)

720 Water Resource Systems: Water Quality - Mathematical modeling of conservative and non-conservative pollutants in aquifers, streams, lakes, estuaries and coastal waters and methods for obtaining least cost correction measures. (4 q.h.)

724 Dynamic Oceanography - Physical and chemical properties of pure and sea water; global energy balance, governing equations, ocean statics, circulation features, stratification, chloride and pollutant distribution; tide prediction and measurement. (4 q.h.)

810 Physical Water and Wastewater Treatment Processes - Principles and design of physical processes for water and wastewater treatment including screening, sedimentation, mixing, flotation, and filtration. (3 q.h.)

811 Biological Wastewater Treatment Processes - Principles and design of biological processes for wastewater treatment. (5 q.h.)

812 Chemical and Advanced Wastewater Treatment Processes - Principles of physical-chemical treatment processes for water and wastewater, including coagulation, softening, absorption, nutrient removal and disinfection. (5 q.h.)

814 Industrial Wastewater Treatment - Principles of industrial wastewater treatment including wastewater surveys; flow reduction, and segregation and equalization; batch and continuous treatment; instrumentation; and treatment processes. (3 q.h.)

Economics:

591 Economics of Environmental Quality - Economic analysis of the relationships among natural resources, growth, pollution control, congestion, and social institutions. (5 q.h.)

Entomology:

532 Pesticide Regulations - Study and discussion of Ohio and U.S. pesticide regulations; rationale of the regulations will be correlated with the biological and environmental effects of pesticides. (2 q.h.)

641 Insect Ecology - The distribution, abundance, population regulation, plant-insect interactions, and species survival patterns of insects are analyzed in relation to microenvironment and ecosystems. (5 q.h.)

660 Advanced Economic Entomology - Theory and practice of pest population management, emphasizing current research and field studies involving practical experience with insect control. (5 q.h.)

662 Principles of Insect Toxicology - The properties of insecticides, modes of action, metabolism, toxicity factors, joint action, resistance, experimental procedures and interpretation of data. (5 q.h.)

841 Biological Control - Reports and discussions on the predators, parasitoids and microbial pathogens affecting plants and invertebrates, particularly insects. (5 q.h.)

Mechanical Engineering:

640 Principles of Environmental Control - A study of the principles of the control of environments for human occupation, occupation by other living beings, the operations of mechanical and electrical equipment, and for the storage and processing of materials. (3 q.h.)

841 Advanced Environmental Control - An advanced study of conventional and unique systems used to control the environment for occupancy by people, equipment, and material. (3 q.h.)

842 Advanced Environmental Control Problems - A study of methods of synthesis and analysis pertaining to the creative design of environmental control systems, involving conferences and theoretical and/or experimental investigations. (1-18 q.h.)

INSTITUTION: OHIO UNIVERSITY

PROGRAM: Environmental Studies

DEPARTMENT: Interdepartmental

DEGREE: Master of Science in Environmental Studies
(For undergraduate degrees available, see addendum.)

CONTACT: Dr. John R. Collier, Associate Dean
Graduate College
Graduate Building
Ohio University
Athens, Ohio 45701
(614) 594-5824

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Established in 1973, the master's degree program in Environmental Studies at Ohio University seeks to prepare students in handling our environmental problems. This interdepartmental program consists of a series of core courses required of all students and two available areas of concentration - the biological sciences (botany, and microbiology and zoology) and the physical sciences (chemical engineering, chemistry, civil engineering, geography, geology, industrial and systems engineering, and mechanical engineering). Students completing this program may enter teaching, government, or business and industry.

The Environmental Studies program is administered by a steering committee with seven members representing participating departments. While courses are generated basically within individual departments, the steering group oversees curriculum matters and operating procedures.

Research facilities are located within individual departments; but students have access to a wide range of scientific equipment including an IBM 370/158 computer, two transmission microscopes and one scanning electron microscope, NMR, EST, automatic X-ray, and I.R. Fourier Transform. Faculty members within the Environmental Studies program have received a number of research grants: a $100,000 National Science Foundation project; a bioethics grant from NEH; demographic grants from the Department of Health, Education, and Welfare and the Department of Housing and Urban Development; a Rockefeller grant to study the impact of over-population on land use and resources; monies for acid-mine research; and state funding for a study of the effects of clear cutting.

Through individual faculty members, the Environmental Studies program is also involved in extension and outreach projects. One staff member periodically conducts environmental education workshops for teachers. Another faculty member has direct responsibility for a summer course in hydrology and water resource evaluation geared to professionals and persons preparing for careers in hydrology; the course has won praise from participants nationally and internationally. Other summer course offerings are designed for school teachers who usually can only attend the university during that term.

PROGRAM REQUIREMENTS

Applicants to the Environmental Studies program must hold baccalaureate degrees in the natural sciences or in engineering, or have equivalent backgrounds in other fields. Degree requirements specify that candidates take at least ten credits in the core courses and a minimum of 16 additional credits in an area of concentration. Both thesis and non-thesis options require at least 48 credit hours. With the thesis, students have nine credits in thesis research and twelve credits in other graduate courses specified by each individual student's advisory committee. If students select the non-thesis degree, they must complete 21 credits in other graduate courses specified by their advisory committees, including three or more credits in a research-oriented course, such as Special Investigations. The required core courses are Animal Ecology or Population Biology, Geographic Perspectives on Resource Management and Conservation, and Environmental Law. If there are deficiencies in one's preparation that would impede graduate work, he or she must take additional transition courses.

CURRENT FACULTY, STUDENTS, GRADUATES

There are no faculty members specifically assigned to the Environmental Studies program; however, nearly 50 faculty from 13 departments are involved through course offerings, service on student advisory committees, and the Steering Committee. There are presently eight full-time and two part-time students enrolled in the program; they represent a heterogeneous blend on disciplines--law, education, geography, sciences, and more. Some are "career-change" students or teachers desiring retraining while others choose the program out of sheer interest in what it has to offer. Students are administratively lodged in individual departments, but they are subject to this program's requirements rather than their own department's requirements.

Approximately 50 percent of the graduates are placed in government positions upon graduation while the remaining 50 percent usually enter or return to teaching. Few if any students pursue additional degrees nor would they necessarily be advised to do so; this master's degree program is essentially a generalist and terminal degree. The program confers roughly 5-10 diplomas annually.

Financial aid to students includes scholarships, tuition-waivers, and teaching and research assistantships within individual departments. A limited number of students engage in field work through faculty grants.

PROGRAM PROJECTIONS

With financial support, the Environmental Studies program at Ohio University could consider giving some faculty members direct responsibilities in the program, even on a part-time basis, in order that more specific environmental courses could be developed. The possibility of offering an environmental education certificate is under consideration though still very much on the drawing board. The stable enrollment in the program is encouraging; but the faculty are very concerned about the job-market situation, especially the lack of employer awareness concerning the scope of skills Environmental Studies graduates can offer. Placement is not a problem now, but it is difficult to obtain information on where jobs are. There exists a consensus among the faculty involved in this program that training monies are needed and that environmental training and problem-solving should be focused at the university level where all aspects of the environment can be studied--technical, economic, and social.

COURSE DESCRIPTION

Core Courses:

Business Law 570 Environmental Law - Legal aspects of individual and societal environmental rights and duties with respect to U.S. Constitution, private property, nuisance, negligence, statutes, court decisions, and rulings affecting policy decisions. (4 q.h.)

Geography 527 Geographic Perspectives on Resource Management and Conservation - Problems in management of renewable natural resources approached from geographic and ecologic viewpoints. (5 q.h.)

Zoology 575 Animal Ecology - Relation of animals to their habitat, to each other, and to man. General principles of terrestrial and aquatic communities, ecosystems, and man's involvement. (3 q.h.)

Zoology 577 Population Biology - Quantitatives aspects of genetics and ecology of plant and animal populations; emphasis on conceptual framework and its application to natural populations. (4 q.h.)

Environmental-Related Courses:

Anthropology 578 Cultural Ecology - Analysis of mutual and reciprocal relations between socio-cultural systems and other systems in their environment; ecosystems and biotic communities in which human populations are included. (5 q.h.)

Botany 625 Plant Ecology - Environmental factor effects on species growth and distribution; review of recent ecological literature. (5 q.h.)

Botany 626 Vegetation Analysis - Analysis of natural plant communities and readings in literature of community ecology. (5 q.h.)

Botany 654 Phycology - Classification, nomenclature, relationships. morphology, reproduction, life histories, and economic importance of fresh-water and marine algae. (5 q.h.)

Botany 754 Experimental Ecology - Theory and methods involved in studying natural plant communities. (5 q.h.)

Botany 757 Topics in Plant Ecology - Theories and principles of plant distribution as related to evolution, migration and speciation of plants. (5 q.h.)

Business Administration 565 Technology and the Environment - There is everywhere a great concern for things to come. Real problem is not just to predict the future but how to anticipate, control and change it. Course is conceptual, future-oriented, and interdisciplinary. Variety of developmental problems and interaction of many technological environments including social, political, economic, marketing, as well as technical. (4 q.h.)

Engineering, Chemical 560 Atmospheric Pollution Control - Air pollution from major industries, internal combustion engines, and other sources. Techniques available for measuring particulate and gaseous pollutants in atmosphere and at their sources. Techniques available for control and future possibilities for control of air pollution. Bases for air pollution legislation. (4-5 q.h.)

Chemistry 579 Radiochemistry - Application of radiation and radioactive isotopes to problems in chemistry and environmental sciences; detection and determination of radiation; safe handling and disposal of radioactive materials and other problems in environmental radiation safety. (4 q.h.)

Civil Engineering 555 Advanced Water Treatment - Advanced study of theory. Design of treatment units. Practice in control methods. (4 q.h.)

Civil Engineering 556 Advanced Waste Water Treatment - Advanced study of theory. Design of treatment units. Practice in control methods. (4 q.h.)

Civil Engineering 558 Water Quality Engineering - Natural and man-made characteristics of water quality, changes in quality resulting from use, criteria for control of stream pollution, methods of improving water quality, legal and economic aspects.

Geography 512 Climate - Exchanges of energy and moisture and their significance in man's utilization of earth's surface. (5 q.h.)

Geography 622 Population Geography - Systematic survey of world population problems including distribution, composition, fertility, mortality, density, age-sex structure, and impact of these on world population growth and resources. (5 q.h.)

Geography 629 Settlement Geography - Patterns and forms of rural settlement in terms of environmental, functional, and traditional effects. (5 q.h.)

Geography 630 Advanced Urban Geography - Such selected topics as internal structure, urban physical environment, and others. (5 q.h.)

Geology 503 Geological Aspects of Environmental Science - Overview of role of geological data in problems concerning mineral and fuel resources, land uses, natural hazards, and pollution of our environment.

Geology 680 Hydrogeology - Principles governing occurrence, movement, and recovery of water in soil and aquifers, water budget, water pollution, water chemistry. (4 q.h.)

Geology 683 Field Hydrology - Field training in techniques of hydrology and water resources evaluation. (6 q.h.)

Industrial and Systems Engineering 567 Environmental Systems Engineering - Overview, analysis, and design of selected environmental systems. Problems selected from area of conversion, resource engineering, communication, bioengineering, transportation, pollution, engineering of large structures, and engineering of community systems. (3 q.h.)

Mechanical Engineering 570 Energy and the Environment - Examination of ramifications of energy in contemporary society. Basic energy concepts; technical considerations of production of energy; conservation strategies; environmental and economic considerations; emerging energy technologies including nuclear, fusion, solar and wind power. Course designed to prepare individual for effective participation in societal actions related to energy and power. (3 q.h.)

Microbiology 511 General Microbiology - Properties of microorganisms and their importance in our environment. Laboratory training in common microbiological methods. (6 q.h.)

Microbiology 512 Microbiological Techniques - Semi-independent course gives microbiology majors extensive experience in use of bacteriological techniques and equipment; information retrieval. (4 q.h.)

Microbiology 518 Epidemiology - Model of spread, cure, and prevention of communicable diseases in humans. (4 q.h.)

Zoology 530 Invertebrate Zoology - Structure, function, systematic, and ecological relationships among full range of phyla. (6 q.h.)

Zoology 537 Medical Entomology - Relationship of insects and related arthropids to human disease. (4 q.h.)

Zoology 560 Animal Physiology - General and comparative physiology emphasizing principal functions underlying life processes. Emphases on physiological adaptations to environment and neurophysiological systems. (4 q.h.)

Zoology 576 Ecology Laboratory - Field course for animal ecology, consisting of visits to and studies of various local terrestrial and aquatic communities. (2 q.h.)

Zoology 779 Experimental Animal Ecology - Research methods in ecology with emphasis on collecting, quantifying, and portraying data obtained during course; population density, dispersion, dynamics, and interactions; community productivity, metabolism, and succession. (6 q.h.)

INSTITUTION: OSCAR ROSE JUNIOR COLLEGE

PROGRAM: Environmental Science

DEPARTMENT: Environmental Science

DEGREE: Associate of Applied Science (A.A.S.) in Environmental Science

CONTACT:
Mr. Harold Fox
Director, Environmental Science
Oscar Rose Junior College
6420 S.E. 15th Street
Midwest City, Oklahoma 73110
(405) 737-6611 x 247

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Associate of Applied Science degree in environmental science is one of 54 degrees offered by Oscar Rose Junior College. Environmental science is a new program at Oscar Rose, which was organized in 1976.

The environmental science degree program emphasis is on preparation of students for a variety of occupations in the fields of pollution control and abatement. The course work offers study in the areas of air, water, wastewater and noise, as well as pest and vector control. Upon completion of this program the graduates are considered to have received sufficient training as generalists to be able to enter the world of work or continue their education. Indicative of the occupations which these students may enter, are: vector control specialists; regulatory specialists; solid waste systems manager; sanitary technician; and engineering aide.

PROGRAM REQUIREMENTS

Students are eligible for enrollment in the environmental science program pursuant to acceptance by the college. There are no special requirements for admission to this program.

Requirements for the two year Associate of Applied Science degree in environmental science include successful completion of the following: 1) general education requirements: 17 semester hours in English, histroy, political science, psychology and physical education; 2) science requirements: 22-24 semester hours in life sciences, chemistry and introductory environmental science; 3) special areas requirements: 23-28 semester hours which include the following courses: ENSC 1113, 2123, 2190, 2223 and 2233; LFSC 2215 and 2225; 4) mathematics requirements: 3 semester hours.

CURRENT FACULTY, STUDENTS, GRADUATES

The teaching and administrative faculty of the environmental science program include three full-time personnel. All three are cost-centered. In addition there are six to seven supplemental part-time faculty which contribute efforts to this program.

Enrollment totals 16 students. There are six male and two female full-time, and seven male and one female part-time students. The average student enrolled in this program is approximately 28 years old. Upward mobility is a major factor which encourages the students to reenter school. The program, however, also attracts career change students.

The first students of this program were granted the associate degree in 1977. The total number of graduates in the first year was three. All of these graduates are pursuing the baccalaureate degree. The institutions receiving these students as transfer were the University of Oklahoma at Norman, and East Central Oklahoma State University at Ada.

PROGRAM PROJECTIONS

Although significant faculty increases or decreases will probably not occur in the near future, there is every indication that this program will experience at least a 10% per annum growth over the next few years.

Two new courses are under development for this program. One course will emphasize occupational health and safety. The other will be a course related to hazardous materials. No time-lines have been established, as yet, for this proposal.

COURSE DESCRIPTION

ENSC 1101 Orientation to Environmental Science - An introduction to the field of environmental science by exploring the opportunities, advantages, and requirements of the profession. (1 s.h.)

ENSC 1103 Introduction to Environmental Science - A cursory survey of man's misuse of the environment; examination of possible control measure for pollution of resources of air, land, water and food. (3 s.h.)

ENSC 1113 Environmental Ecology - An examination of man and his environment through discussion and observations of cultural and social impacts. (3 s.h.)

ENSC 2213 Wastewater Plant Equipment II - Theory of operation and maintenance of electrical, electronic, pneumatic control systems and other electromechanical equipment found in wastewater treatment facilities. (2 s.h.)

INSTITUTION: OSU OKLAHOMA CITY TECHNICAL INSTITUTE

PROGRAM: Environmental Health

DEPARTMENT: Civil Technology

DEGREE: Associate of Science (A.S.) in Civil Technology

CONTACT: Mr. Garland C. Pendergras
Director, Civil Technology
OSU Oklahoma City Technical Institute
900 North Portland
Oklahoma City, Oklahoma 73107
(405) 272-0533

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The OSU Oklahoma City Technical Institute is an institution charged with the responsibility of training for employment in various career fields. The Institute may be described as quasi-independent of the Oklahoma State University. Located in central Oklahoma City, the Institute offers two-year career oriented training programs which may lead to the Associate of Science degree. Educational methods emphasize applied procedures. In response to the needs of the students, the theoretical approach to teaching and learning is stressed to a lesser degree. The majority of the students are employed full-time and thus the accomplishment of the Associate of Science degree usually requires a prolonged time period, in excess of the two years normally allocated to associate level studies by full-time students.

The Institute addresses the needs of a targeted population which includes Oklahoma City residents almost exclusively. The Institute is rather strategically located within the city in order to meet the student occupational training and academically related needs. Students are prepared to enter the world of work at the technician level. At the same time, the credits are transferable to baccalaureate programs.

The Associate of Science environmental health concentration is one of at least 14 two-year career preparation programs offered by the Institute. This particular program has been available through the Institute since 1971.

PROGRAM REQUIREMENTS

Achievement of the Associate of Science degree requires successful completion of at least 68 credit hours. The curriculum is arranged so that at least 10 hours are common requirements for all students. In addition, 10 credit hours of mathematics are requirements in common for all engineering technology students. The environmental health curriculum places particular emphasis on the areas of air and water resources. To be eligible for the associate degree, students must maintain an overall grade average of "C" or better in all courses applicable to the degree.

The program does not require a minor. Major area course requirements include 26 credits in civil technology courses which include the following: CIVT 1102, 1212, 1232, 2123, 2133, 2343, 2643, 2704 and 2753.

CURRENT FACULTY, STUDENTS, GRADUATES

The current faculty allocated to the environmental health program includes one part-time and two full-time instructors. Two of these faculty members are cost-centered.

Student enrollment in this program includes 20 part-time registrants. The average student in this program is approximately 30 years old. Very few students are considered as full-time. Of the 2,300 total students at the Institute, approximately 30% may be classified as full-time. The current complement for this program consists of 85% male and 15% female students.

The average number of graduates from this program is two or three per annum. Historically, students pursue this program from four to six years in order to complete the Associate of Science degree requirements. This extended time-frame is attributed to the fact that most of the students are employed full-time, thus precluding enrollment in the normal complement of courses. A number of students, upon completion of the occupationally oriented courses, encounter problems (either real or imagined) which curtail their continuation of the academic requirements. The Institute meets this challenge by offering remedial level English and math. Although these are no-credit courses, often they enable the students to up-grade in areas in which they were previously deficient.

Approximately 30% of the students elect to pursue the baccalaureate upon completion of the Associate of Science degree.

Federal, state and local monies assist in the area of student tuition support, to a limited degree.

PROGRAM PROJECTIONS

Future planning at the Institute emphasizes expansion of this program pursuant to the needs of the population served. Faculty anticipate an approximate 5% per annum growth rate for this program.

COURSE DESCRIPTION

CIVT 1012 Introduction to Public Works - A survey course designed to expose the beginning student to the organization, function and

CIVT 1012 (cont'd) - administration of public works; including utilities, streets and drainage, permits and inspection, traffic control, water supply, and pollution control.

CIVT 1102 Introduction to Environmental Health Technology - This course is designed to give the student an introduction to the environmental problems in the ecological/technological system. A general progression of the history of the world environmental problems with a prospectus for the future. Basic laboratory and field techniques for environmental studies will be undertaken by the students. (3 s.h.)

CIVT 1113 Traffic Control and Safety Devices - Traffic control devices, methods and planning, signalization, signing, channelization and lighting.

CIVT 1123 Materials of Construction - A study of the properties and use of materials relative to the construction of roadways, dams and bridge-type structures, including testing of soils, asphalt and concrete. (3 s.h.)

CIVT 1213 Air Quality Control Technology - Study of the causes, effects and control of air pollution, how individuals, communities, metropolitan areas, and industry can prevent pollution. Students will conduct atmospheric sampling and laboratory analysis studies. A large proportion of this course will be directed toward laboratory procedures. (3 s.h.)

CIVT 1232 Principles of Hydraulics - Principles of fluid mechanics, pressure conduits, open channel flow, fluid measurement, drainage structures, design of collection systems for municipal drainage. (2 s.h.)

CIVT 2103 Highway Design and Construction - Study of transportation roadways and their functions. Roadway foundations; pavement types, characteristics, composition and structural design; construction procedures; transportation systems planning.

CIVT 2113 Urban Transportation Systems - Special problems of the metropolitan transportation systems are considered including economics, financing, planning, right-of-way, and projecting future developments.

CIVT 2123 Solid Wastes Disposal - Devices, techniques and procedures for solid wastes collection and disposal; theory of combustion and incinerator design; solid waste management. (3 s.h.)

CIVT 2133 Industrial Hygiene Technology - Practices and procedures concerning industrial hygiene and safety; review of state and federal laws; evaluation and control of occupational environmental hazards including dust, noxious gases, abnormal temperature and pressure, noise control, and lighting. Extensive laboratory work will be conducted at on-site locations with local industry. (3 s.h.)

CIVT 2143 Water Bacteriology - The role of bacteria, molds and other microorganisms in relation to community health and sanitation, in

CIVT 2143 (cont'd) - water supply treatment and in waste forms. Laboratory exercises stress modern techniques of bacterial identification and procedures necessary to assure the bacteriological safety of water. (3 s.h.)

CIVT 2232 Route Surveying - Principles of route surveys, use of photogrammetry in route design and layout. Computer applications. (3 s.h.)

CIVT 2313 Strength of Materials - Study of forces, stress and strain and their effects on materials; analysis of trusses, torsion and couples. (3 s.h.)

CIVT 2323 Inspection Principles - A practical course especially designed to acquaint the student with the importance of the inspector's job, the basic field procedures and modern methods of testing compliance with specifications. (3 s.h.)

CIVT 2343 Environmental Control Instrumentation - Application of mechanical and electrical control systems needed in air and water sampling and testing devices and their performance characteristics, accuracy and application. Laboratory work related to operations, maintenance and reliability studies of instrumentation will be included. (3 s.h.)

CIVT 2423 Advanced Surveying and Photogrammetry - Care and adjustment of instruments, controls by triangulation, photographic methods of mapping including ground control in aerial surveys, measurement and computation of earthwork, topographic surveys with conventional instruments and photographic methods. Oklahoma laws governing land surveys and professional licensing. (3 s.h.)

CIVT 2543 Transportation and Traffic Analysis - Conducting transportation and traffic analysis surveys and studies; their applications to capacities and planning.

CIVT 2633 Codes, Contracts and Specifications - Since the civil technician may be responsible for field inspection, it is necessary for him to be familiar with how specifications and related documents are written and used in the construction industry.

CIVT 2643 Water Resources and Treatment Processes - Water and its impurities; dams and reservoirs; underground and surface supplies, water for industrial use, water and waste treatment plant maintenance, operation and safety, industrial wastes, swimming pools, water quality standards.

CIVT 2704 Environmental Sanitation - Problems of general sanitation including water supply, domestic and industrial waste disposal, vector control, epidemiological studies, pesticides and chemical pollutants, food sanitation, recreation camps and swimming pool sanitation, sanitation inspection principles. (3 s.h.)

CIVT 2753 Concepts in Ecology - Study of biological interrelationships in the cycle of life: population dynamics, ecosystems, energy flow, and impact of pollution of the environment. (3 s.h.)

INSTITUTION: POLYTECHNIC INSTITUTE OF NEW YORK

PROGRAM: Environmental Engineering and Planning

DEPARTMENT: Civil and Environmental Engineering

DEGREE: Master of Science in Civil Engineering (M.S.C.E.)
Master of Environmental Health Sciences (M.E.H.S.)
Engineer
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Henry F. Soehngen
Chairman, Department of Civil and Environmental Engineering
Polytechnic Institute of New York
333 Jay Street
Brooklyn, New York 11201
(212) 643-2322

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental Engineering and Planning is one of six specializations offered by the Department of Civil and Environmental Engineering. This program developed from the Civil Engineering curriculum in the 1940s. About ten years later a program in Environmental Health Sciences was added.

Four separate concentrations are offered within this specialization: water quality engineering, air resources engineering, environmental health science, and environmental planning. Generally, a student will plan his course of study within any one of these areas. In the environmental health sciences concentration a student can receive the M.E.H.S. or the Ph.D. in Environmental Health Sciences, but not the Engineer degree. All other concentrations award the degrees of M.S.C.E., Engineer, or Ph.D. in Civil Engineering.

Program support is provided by the laboratory facilities of the Civil and Environmental Engineering Department and the Institute's Center for Urban and Environmental Studies, which initiates and coordinates programs of research and instruction in areas such as air and water pollution control, water resources, and solid waste disposal.

PROGRAM REQUIREMENTS

Admission to any of the graduate programs requires a bachelors degree from an acceptable institution and scores from the Graduate Record Exam. For the M.S.C.E. degree, a bachelor's degree in civil engineering is required. The M.E.H.S. program generally requires an undergraduate degree in science, although applicants with degrees in other fields may also be admitted. A master's degree in civil engineering is normally the requirement for entry into the Engineer or Ph.D. programs. A student may, however, be admitted to the Ph.D. program in environmental health science with a Master's degree in science.

Either Master's degree offered requires a minimum of thirty-six units of credit. This includes both prescribed courses and electives. A thesis or a project may be substituted for elective courses. The Engineer degree requires at least thirty-six units of work beyond the Master's level and includes a twelve unit design project. Requirements for the Ph.D. include a minimum of sixty-six units of academic credit, of which at least twenty-seven must be formal course work and thirty must be dissertation research. The Ph.D. program generally consists of one major field of concentration plus the minor fields. A dissertation and reading knowledge of one modern foreign language are also required.

CURRENT FACULTY, STUDENTS, GRADUATES

Faculty for the program consists of twelve full-time members. Most time is devoted to teaching, although about one-sixth of the faculty member's time is spent on research. Research funding is available from the New York State Energy Office and the National Science Foundation. At one time the program did receive EPA training grants.

There are currently two full-time and fifteen part-time students in the environmental health sciences programs and twelve full-time and one-hundred and fifteen part-time students in the environmental engineering programs. Students in these programs generally come from either the New York City metropolitan area or from foreign countries. Approximately fifty percent of the students are foreign. Recruitment of students is generally achieved through informal contacts of faculty and alumni. The distribution of brochures to employers and advertising in newspapers are other means of recruitment. Principal forms of student financial assistance include research assistantships, teaching fellowships, and tuition payment by employers.

Environmental health sciences graduate about five students per year and the environmental engineering programs graduate approximately seventy-two students each year. Both figures are indicative of a downward trend in enrollment. Most graduates go directly into employment with private industry and government agencies. Since most students are working while they are in the program, placement of graduates is not considered to be a problem.

PROGRAM PROJECTIONS

Program officials anticipate the addition of more courses to the program and expansion of research acitvities in water quality. This would probably require the addition of two faculty members. No estimate is available on when these changes may occur.

COURSE DESCRIPTION

(the following is a partial listing of courses)

CE 738 Sanitary Chemistry - Review and application of principles of chemistry to waters and wastewaters. Laboratory. (3 s.h.)

CE 740 Sanitary Microbiology - Microbiology of wastewater treatment processes, wastewaters, receiving waters. (3 s.h.)

CE 742 Water and Wastewater Treatment I - Study of physical, chemical, and biological principles involved in process design and treatment of water and wastewater. (3 s.h.)

CE 747 Analysis of Stream and Estuary Pollution - Analysis of dispersal and decay of contaminants introduced into lakes, streams, estuaries, oceans. Effects of pollutant on chemical quality and ecology of receiving waters. (3 s.h.)

CE 751 Environmental Health Engineering - Theory, methodology, and instrumentation associated with environmental health. (3 s.h.)

CE 752 Air Pollution - Study of the causes and effects of air pollution. Methods of sampling. Methods of air pollution control. (3 s.h.)

CE 753 Dispersion of Pollutants - Introduction to theory of diffusion of pollutants and methods for estimation of dispersion in atmosphere. Dispersion of pollutants in sea, lakes, rivers. Other topics. (3 s.h.)

CE 755 Air Pollution Chemistry - Significant chemical reactions occurring in lower atmosphere and basic chemistry required to understand problems peculiar to air pollution field. (3 s.h.)

CE 758 Air Pollutant Engineering Control - Fundamentals of adsorptive, absorptive, and reactive recovery and control; removal of gaseous oxides of nitrogen, carbon, and sulfur; removal of particulates from moving and stationary sources; other topics. (3 s.h.)

CE 760 Planning and Engineering of Urban Environmental Systems I - Consideration of sociological, political, and economic values in planning and engineering of urban communities. (3 s.h.)

CE 770 Solid Waste Management - Engineering aspects of solid waste collection, transport and disposal, including incineration, sanitary landfill, composting, recovery and reutilization, economic evaluation of factors affecting selection of disposal methods. (3 s.h.)

INSTITUTION: PURDUE UNIVERSITY

PROGRAM: Environmental Sciences Option

DEPARTMENT: School of Science

DEGREE: Bachelor of Science

CONTACT: Dr. James Yackel, Associate Dean, School of Science
Purdue University
Mathematical Sciences Building
West Layfayette, Indiana 47907
(317) 494-8500

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The program began in 1973 and more than 70 courses are offered. It is interdisciplinary within the School of Science, although course work from many departments is accepted towards the environmental science option.

Options open to students include, but are not limited to: general environmental studies, air pollution, water pollution.

General environmental studies can be agriculturally oriented or science and engineering oriented. A minor in air pollution might be combined with a major in atmospheric sciences. A minor in water pollution might be combined with chemistry and geosciences. Each program is tailored to the student's professional orientation with the help of a faculty member or academic adviser.

PROGRAM REQUIREMENTS

Freshman admission requirements to the School of Science are:

1) high school graduate with 16 units: English (6), History or Social Studies (2), Algebra (3), Geometry (2), Trigonometry (1), Laboratory Science (2);
2) Indiana residents must be from the upper half of their high school graduating class and have SAT scores in the upper half of national norms;

   Out-of-state must be in the upper third of their high school graduating class and have SAT scores in the upper third of national norms;

3) SAT scores and College Entrance Examination Board achievement tests in English, Mathematics, Chemistry (used for academic placement);

4) information provided by high school counselor.

A B.S. in the General Science program requires 124 credit hours:

general scientific studies	35 - 40 hours
major science concentration	12 - 23 hours
additional scientific studies	4 - 10 hours
minor concentration	18 hours
general humanistic studies	27 - 28 hours
free electives	5 - 28 hours

In preparation for the environmental science minor,Ecology: BIOL 585-586, Programming I: CS 220, Experimental Statistics I: STAT 501, and one or more of 11 specified courses from Economics, Political Science or Sociology should be taken.

CURRENT FACULTY, STUDENTS, GRADUATES

There is no special faculty for the environmental studies options. Courses are offered through the regular academic departments of the School of Science and the faculty there numbers 280. Research has been done with Lake Michigan shore erosions, northern Indiana dunes, population ecology and field ecology.

Presently there are 15 enrolled in the program; 4 graduate yearly. Fifty percent of the students receive employment in government 25 percent in industry and 25 percent in other areas.

About 200 undergraduate students are assisted financially through teaching assistantships, research assistantships or an hourly wage. A co-operative program is also available. Students complete two years of school and then, while working on campus or during the summer, take four credit hours a semester. Obtaining a degree in this manner takes four and one-half years. In the past, arrangements have been made with government labs (i.e., Argonne) to provide these opportunities.

PROGRAM PROJECTIONS

The department sees no change in the long range goals and objectives of the program. The various options are seen as continuing to be chosen by a small number of students. The impetus for change will need to come from a small nucleus of faculty.

ADDITIONAL INFORMATION

The School of Science has four departmental libraries: Chemistry, Geosciences, Mathematical Sciences, and Physics. The Department of Biological Sciences is served by the Life Science Library.

COURSE DESCRIPTION (a partial listing; others available from agriculture, entomology forestry, horticulture, civil, mechanical, electrical engineering)

Undergraduate:

Bio. Sciences: 285 Environmental Biology - Interactions of the biotic and abiotic components of natural environments. Ecological principles and phenomena associated with populations, communities, and ecosystems. Natural selection and other aspects of evolution. Principles of conservation. (3 s.h.)

Computer Sciences: 220 Programming I - Introduction to the intuitive notion of an algorithm; representation of algorithms in narrative form as flow charts and as computer programs; general structure of computers; computer experience using a procedure-oriented language in programming algorithms such as those used in elementary numerical calculations, sorting, simulation of a random process and symbol manipulation; definition and use of functions, subroutines and iterative procedures; survey of a variety of significant uses of computers. (3 s.h.)

Physics: 200 Our Physical Environment - Selected topics in physics which relate to man's environment. Particular emphasis will be placed on energy resources, relationships between medicine and physics, and modern applications of discoveries in physics. (3 s.h.)

Undergraduate/Graduate courses:

Atmospheric Sciences: 539 Air Pollution Meteorology - Sources of air pollution and variations of pollutants with space and time. Concepts of hydrostatic stability and turbulent flow in the atmospheric boundary layer, with application to urban diffusion models. Requirements and limitations of air pollution measurements, a total monitoring program and analysis of data. The role of macroscale circulation systems and large scale weather prediction in air pollution potential forecasting. Principles of radiation transfer and cloud physics applicable to potential climate modification by air pollutants. (3 s.h.)

Biological Sciences: 585 Ecology - Examination of ecological principles derived from study of patterns of distribution and abundance in plants and animals; structure and function in populations, communities, and ecosystems; role of population genetics, adaptation, and evolutionary theory in ecology. (2 s.h.)

586 Laboratory in Ecology - Laboratory and field studies designed to demonstrate ecological principles; sampling

586 (Cont'd) - methods and problems of experimental design; application of selected statistical methods in the analysis and interpretation of data; simulation models in population genetics, population ecology and ecosystem function. (2 s.h.)

Statistics: 501 Experimental Statistics I - Fundamental concepts and methods of statistics for students interested in the analysis of experimental data. Subjects include descriptive statistics, basic probability theory, normal distribution, tests of hypotheses and confidence intervals for normal and Bernoulli populations, contingency tables, tests of goodness-of-fit; linear regression and nonparametric tests. (3 s.h.)

INSTITUTION: RAYMOND WALTERS GENERAL AND TECHNICAL COLLEGE OF THE UNIVERSITY OF CINCINNATI

PROGRAM: Environmental Control/Protection Technology

DEPARTMENT: Biology

DEGREE: Associate in Science

CONTACT: Dr. Judith M. Schultz, Director
Environmental Control/Protection Technology
Raymond Walters General and Technical College
University of Cincinnati
9555 Plainfield Road
Cincinnati, Ohio 45236
(513) 745-4200

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

An admission requirement to the Environmental Control/Protection Technology program at Raymond Walters is "an interest in combating pollution." To this end, students pursue Associate in Science degrees preparing them for "work as technical assistants to environmental biologists, chemists, engineers, and physicists" or employment in "government and industry in the fields of air, water, and solid waste pollution control, and in related areas of environmental health." Training reflects the dual philosophy of the college: to graduate students with a general education who are at the same time adaptable, thinking technicians.

Budgetary considerations require the multidisciplinary Environmental Control/Protection Technology (EC/PT) program to be housed in the Department of Biology. Nonetheless, students can expect their coursework to involve "surveys of environmental issues and problems; air, water, and solid waste pollution control engineering; nationally approved water and air sampling and analysis techniques; biology, chemistry, and physics courses; communication skills; salaried internship with federal government or industry; and a well-rounded college program."

Research and support facilities are equipped for teaching a variety of techniques and instrumentation: BOD, COD, DO, and TOC tests, benthic diversity indices, fish, and plankton sampling; *Standard Methods* and E.P.A. approved water analyses; data collection and analysis; coliform and MPN analysis; atomic absorption; Ringelman tests; stack and ambient sampling; spectrophotometry; titration; dilution; gravimetric and volumetric analysis; instrument calibration; SO_2, NO_2, and O_3 analyses; and sewage digestion analysis. Students have access to a gas chromatograph, high volume sampler, Pitot tubes, turbidimeters, pH meters, and analytical balances. The program emphasizes a "hands-on," one-to-one relationship of student to equipment.

The College is essentially a teaching institution with no real research activities. Several faculty in the EC/PT program do publish in environmentally-related journals. One staff member, with Environmental Protection Agency funding, has developed an individualized training program in water treatment. The program director's interest in population research has resulted in publications, in-service courses for high school teachers, and contributions to ERIC (Educational Resources Information Center). An advisory committee composed of 26 individuals from local industry and consulting firms, the University of Cincinnati, and the nearby research units of the National Institute of Occupational Safety and Health and the U.S. Environmental Protection Agency provides curriculum oversight and training recommendations to improve the marketability of graduates.

The internship scheduled for the final quarter in the program sequence facilitates job placement as well as giving students a supervised, on-the-job training experience. To date, internships have been in industry (Proctor and Gamble, Formica Corporation, Snow Filtration, Hilton-Davis); government (Environmental Protection Agency, National Institute of Occupational Safety and Health); and environmental consulting firms in the area.

PROGRAM REQUIREMENTS

Applicants must be graduates of an accredited high school or have completed the GED and take either the ACT (minimum comp score of 19) or the SAT (minimum total of 875, verbal 400) and the Raymond Walters Placement test in mathematics. Students are encouraged to have had one or more sciences in high school. Those with poor academic records in high school are often placed in remedial programs giving them a long-range entrance into the EC/PT program and a chance for schooling. Students must complete a minimum of 103 quarter hours to attain the Associate in Science degree offered by this program.

CURRENT FACULTY, STUDENTS, GRADUATES

Seven faculty members (four full-time and three who teach modular sections) serve the seventeen full-time and eight part-time students currently enrolled in the EC/PT program. The curriculum very definitely attracts career-change students, especially baccaulaureate graduates in the physical, biological, and social sciences for whom graduate school is not an option and employment opportunities are limited. The program graduates approximately twelve to fifteen students annually. Job placement records indicate that roughly 16 percent enter industry, 16 percent enter consulting, and 66 percent enter government work.

Financial support is available in the form of scholarships and standard student loan and grant programs administered through the Student Affairs Office. Also, interns receive salaries based on their educational background and at level comparable to similarly-educated full-time employees in the firm or agency sponsoring their internship.

PROGRAM PROJECTIONS

The Environmental Control/Protection Technology program projects the implementation of occupational health courses in the summer session--classes primarily for persons already in the field. Decisions regarding integration of such course into the regular curriculum will depend largely on the results of a survey of area industry and business regarding their manpower needs for two-year technicians in this area. The dual emphasis on general education and diverse technical training produces graduates that are in demand in industry and consulting. The proximity of environmental agencies and firms and industries with environmental concerns fosters a student awareness of the growing numbers of jobs in this technical area. Enrollment figures indicate more people are taking coursework part-time while employed full-time. However, luring students into the field when they have little conception of what it offers or demands remains a problem in Cincinnati and nationwide.

COURSE DESCRIPTION

Environmental Control/Protection Technology:

241 Environmental Engineering I - Module 1: Introduction to air contaminants, and engineering approaches for source sampling, analysis and control. Module 2: Introduction to solid waste pollution and engineering control methods. (3 q.h.)

251 Environmental Engineering Lab - Laboratory corequisite to Environmental Engineering 241. Stack sampling, particulate analysis and visitation to solid waste pilot projects. (1 q.h.)

242 Environmental Engineering II - Module 1: Introduction to solid waste pollution and engineering control methods. Module 2: Introduction to wastewater pollutants and engineering approaches for sampling, analysis, and control. (3 q.h.)

252 Environmental Engineering Lab - Laboratory corequisite to Environmental Engineering 242. Visitation to solid waste pilot projects; water purification and sewage treatment analysis techniques. (1 q.h.)

275 Environmental Physics - A survey of selected topics including heat, sound, and radiation as related to environmental control and industrial health. (4 q.h.)

271 Environmental Field Internship - Cooperative internship opportunity with local industrial and governmental environmental management systems. (12 q.h.)

071 Environmental Career Orientation - Presentations by guest lecturers related to career opportunities, resume preparations and procedures for employment application, site visits to environmental control/protection facilities. (1 q.h.)

Biology:

141, 142 Man and Environment I, II - A discussion-lecture seminar series of selected topics dealing with problems of pollution, environmental management, and public and industrial health. Occasional guest presentations by experts in the community. (3 q.h. each qtr.)

272 Biological Water Sampling and Analysis - Field and laboratory sampling utilizing methods approved by Standard Methods/E.P.A. Plankton, benthic diversity indices, coliform and ichthyologic studies. BOD. (4 q.h.)

275 Contemporary Ecological Problems - Seminar on current environmental issues, and their historical, biosocial, and ethical implications. Presentation of classical and contemporary case studies. (3 q.h.)

Chemistry:

281 Chemical Air Analysis Lecture - Sampling and analysis of current air pollution parameters by classical and instrumental methods. (3 q.h.)

291 Chemical Air Analysis Laboratory - Experimental work supplementary to 291. Application of gas laws to air movers and air measuring instruments; calibration, operation of such instruments as air sampling units, UV, visible, and atomic absorption spectrophotometers, and gas chromatographs; performing laboratory analysis for SO/2, NO/2, O/3, metals, particulates, and aldehydes. (1 q.h.)

282 Chemical Water Analysis Lecture - Sampling and analysis of current chemical parameters of water quality by classical and instrumental methods. Familiarization with federal water quality standards and acceptable methodologies for various water quality parameters including alkalinity, acidity, hardness, fluoride, sulfate, nitrogen, mercury, phosphate and solids. (2 q.h.)

292 Chemical Water Analysis Laboratory - Experimental work supplementary to 282. Development of basic laboratory techniques including electrometric titration, colorimetric techniques, and assembling a distillation apparatus. Use of basic laboratory equipment such as a pH meter, spectrophotometer, and Coleman Mercury Analyzer. Exposure to atomic absorption and chromatographic techniques. (2 q.h.)

INSTITUTION: RENSSELAER POLYTECHNIC INSTITUTE

PROGRAM: Environmental Engineering

DEPARTMENT: Chemical and Environmental Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Engineering (M.E.)
Master of Science (M.S.)
Doctor of Engineering (D.E.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. David Hansen, Chairman
Dr. William W. Shuster
Environmental Engineering Program
Chemical and Environmental Engineering Dept.
Rensselaer Polytechnic Institute
Troy, New York 12181
(518) 270-6377

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Chemical and environmental engineering are combined as disciplines at the Rensselaer Polytechnic Institute into the Chemical and Environmental Engineering Department. Rensselaer is one of the few institutions of higher education in the United States which offers a baccalaureate degree in environmental engineering. The Environmental Engineering Program builds on a broad base of studies in chemistry, life science, and engineering science in a three-year pre-engineering portion of the program, and during the senior year students receive specialized study in environmental engineering. The senior year consists of a sequence of courses designed around unit processes and integrated laboratory design courses. Employment for graduates of the program may be found in industry, consulting, government, research agencies and teaching.

On completion of the three-year pre-engineering curriculum, an undergraduate may continue to the two-year professional program leading to the Master of Engineering degree. Students electing the professional program may elect any of four options emphasizing water resources, solid waste, air pollution or radiological health. The Master of Engineering degree is awarded on completion of specified programs which are accredited by the Engineers' Council for Professional Development. The Master of Science degree is awarded on completion of a program which is individually arranged and appropriate to the major field. The Doctor of Engineering and Doctor of Philosophy degree programs are also arranged individually and emphasis is placed on advanced study in a specialty, with a major focus on thesis work. At the graduate level, students are encouraged to take cross-disciplinary studies using other Rensselaer courses outside of the department.

The department utilizes extensive research and instructional laboratories with a broad range of process and analytical instrumentation. Water resources laboratories are located at the Fresh Water Institute at Lake George. Current research is conducted in the study of water resources and its subtopics of treatment technology, environmental monitoring, and modelling of water ecosystems. Other environmental engineering research efforts are being directed in the area of air resources, solid wastes, radiological health, and other related areas. Some interdepartmental research is also being conducted with other departments in the areas of environmental acoustics, radiological health, water resources, and bioengineering.

PROGRAM REQUIREMENTS

Students seeking admission at the same level to the baccalaureate program must first be admitted to the university and satisfy the pre-engineering requirements. Junior college transfers can enter the program at the third year as long as their educational backgrounds are equivalent to what is offered during the first two years at Rensselaer. Department officials stated that prospective students should have taken four years of high school mathematics and science and have graduated in the top 10 percent of their class.

The Master of Engineering program, administered by the Professional School is EPCD-accredited, and graduates of other schools may be admitted with advanced standing and may normally complete the degree program in one year, if their baccalaureate engineering degrees are accredited. Master of Engineering candidates must: (1) be admitted to the Professional School of Engineering; (2) fulfull the general requirements; (3) complete the prescribed curriculum in the Professional School satisfactorily, and (4) complete an engineering project.

A total of 133 hours is required for completion of the Bachelor of Science degree in Environmental Engineering. In addition to the three-year pre-engineering program totaling 102 hours, the two-year Master of Engineering program requires completion of an additional sixty-one hours. The doctorate requires completing ninety credits beyond the bachelor's degree and a doctoral thesis or engineering project.

Although Rensselaer has established an Industrial Traineeship Plan, there is no sponsorship under this plan for environmental engineering students. The Chemical and Environmental Engineering Department does participate in a cooperative education program with industry. In the cooperative plan programs, students alternate periods of employment with periods of on-campus education; however, there is no financial support from the sponsor directly to the student's educational program.

Normal federal financial aid programs are available to students at the undergraduate level. At the graduate level, the only source of funding for students is research contracts. Training grants have almost disappeared and one U.S. Environmental Protection Agency fellowship is being funded. In addition, one industrial fellowship is available.

CURRENT FACULTY, STUDENTS, GRADUATES

Ten faculty members are currently involved with teaching and research activities associated with the Environmental Engineering program. Many faculty members are involved in both portions of department's program. It is estimated that there are four and one-half full-time equivalent faculty members each involved with teaching and research.

At the undergraduate level during the pre-professional program, students are not identified as being environmental engineering oriented. While there are about twenty seniors in environmental engineering, this is out of a total of about 800 senior undergraduates in the engineering school. There are no part-time undergraduate environmental engineering students enrolled.

Fifty-four graduate students have chosen to specialize in environmental engineering at Rensselaer. Of these, forty are full-time students; two are female. There are fourteen part-time students taking graduate environmental engineering programs, and of these, one is female. It is estimated that 3½ percent of the undergraduate and 5 percent of the graduate students in the School of Engineering elect environmental engineering.

Within the last five years, an average of twenty-five undergraduates received baccalaureate degrees in environmental engineering at Rensselaer. At the graduate level, within the last three years on an average, twenty students have received master's degrees and three have received doctorates.

With the decline of training grants from the U.S. EPA, Rennselaer has felt less tied to offering specific curriculum specializations to environmental engineering students. Emphasis at the undergraduate level has been placed on providing students with a solid fundamental environmental engineering background. Master's students are required to complete a six-credit thesis, and the topic is usually in the student's chosen area of specialization. Approximately one-third of the master's program includes required fundamental courses. About one-half of the environmental engineering students elect to specialize in the water resources area. One-fourth elect the air option, and one-fourth select the other two remaining areas of concentrations.

Due to increasing governmental cutbacks in hiring, most of the environmental engineering graduates have found employment within private industry (mainly consulting firms.) There are a consistent number of graduates employed by industry involved in the design and manufacture of equipment for environmental control. Other graduates find employment with research groups and within academia.

PROGRAM PROJECTIONS

Although the Rensselaer environmental engineering program is not expected to significantly change in size and emphasis over the next five years, research programs may be expanded. Two additional environmental engineers with air or water resources backgrounds may be recruited for an expanded research program. An environmental science degree may be developed at Rensselaer within the School of Science as the Biology Department is active in environmental studies.

Rensselaer officials expect enrollment in environmental engineering to begin to level out, and keep pace with population trends. More emphasis in the next few years is expected to be in the application of chemical processing in the pollution control areas. The curtailment of the EPA training grant program has had a serious effect on the number of students entering environmental engineering graduate programs at Rensselaer. Departmental officials feel that there is a need to reinstate the EPA training grant program.

A main attraction of the Rensselaer environmental engineering program is the fact that it is one of the strongest undergraduate programs in environmental engineering in the United States. The graduate program is also considered to be one of the premier environmental engineering programs in the nation.

COURSE DESCRIPTION

32.405 Unit Operations in Environmental Engineering - A study of the physical processes, termed unit operations, that are common to air, water, and land pollution control systems. (3 s.h.)

32.406 Unit Processes in Environmental Engineering - The study of several physical-chemical and biological processes encountered in environmental pollution control and water supply. (3 s.h.)

32.407 Environmental Acoustics - A study of man's total sonic environment. (3 s.h.)

32.409 Water and Wastewater Engineering - The topics studies are: estimates of water demands, water supply sources, water quality criteria, transmission and distribution of water, water pumping and storage systems, rural water supply and other topics. (3 s.h.)

32.415, 32.416 Environmental Engineering Laboratory I & II- Experiments are performed in the areas of water, wastewater, solid wastes and air pollution. (2 s.h. each)

32.423 Air Pollution: Sources and Effluents - Fundamental aspects of air pollution with emphasis on emissions from major stationary and mobile sources (automobiles). (3 s.h.)

32.431 Solid Waste Engineering - Classification and characteristics of solid wastes, the need for and rating of solid waste management systems, design of municipal refuse collection and transfer systems, methods and costs of solid waste disposal, and other subjects. (3 s.h.)

32.442 Industrial Waste Treatment and Disposal - Physical, chemical and biological characteristics of industrial wastes. (3 s.h.)

Graduate Courses:

32.601 Public Health I - Occurrence and control of communicable diseases; principles of epidemiology and biostatistics and their application, emphasizing the relationship with environmental factors; air pollution sources and health effects. (2 s.h.)

32.602 Public Health II - International, federal, state and county health organizations, responsibilities, and functions; water quality management and public water supplies; solid wastes management; radiological health controls; air resources controls and management. (2 s.h.)

32.603 Chemistry for Environmental Engineers - The weekly 3-hour laboratory emphasizes analytical measurements using instrumental techniques; most experiments are drawn from the water and wastewater field, a few from air pollution. (3 s.h.)

32.611 Water Resources - Elements of meteorology and hydrology. Precipitation, runoff, stream flow, watershed losses, unit hydrograph, and groundwater problems. (3 s.h.)

32.612 Physical Chemical Waste Treatment - The application of theoretical principles and pilot plant data to the design and operation of advanced waste treatment systems. (3 s.h.)

32.614 Stream Pollution Control - The economic aspects of water pollution; health aspects of bacterial pollution. (3 s.h.)

32.616 Environmental Impact Analysis - Studies related to the evaluation of the impacts of major actions by state and federal agencies on the quality of human environment. (3 s.h.)

32.620 Atmospheric Chemistry - The course presents important thermodynamic and kinetic aspects of reactions in the atmospheric layer. (3 s.h.)

32.622 Air Pollution Meteorology - Investigation of atmospheric processes of particular importance in dealing with the environmental problems of air pollution. (3 s.h.)

32.624 Air Pollution Control - The major approaches to air pollution control are discussed from three different viewpoints. (3 s.h.)

32.634 Environmental Radiation Safety Controls - Consideration and control of the health hazards peculiar to the atomic industry. (4 s.h.)

INSTITUTION: RUTGERS - STATE UNIVERSITY OF NEW JERSEY

PROGRAM: Environmental Science
DEPARTMENT: Environmental Science
DEGREE: Master of Science (M.S.); Doctor of Philosophy (Ph.D.)

CONTACT: Professor A. Joel Kaplovsky
Director of Graduate Programs in Environmental Science
401 Georges Road Laboratories, Cook Campus
Rutgers - State University of New Jersey
New Brunswick, New Jersey 08903
(201) 932-9571

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Environmental Science at Rutgers has long-standing multidisciplinary graduate teaching and research programs since inception in 1920. This problem-oriented program deals primarily with technological solutions to the contamination of our environment from particulate matter, gases, vapors, liquids, and undesirable organisms. Emphasis is placed on the application of the physical, chemical, and biological sciences toward this end. The following areas of specialization are offered: air resources; aquatic biology; aquatic chemistry; chemistry and physics of aerosol and hydrosol systems; environmental chemistry; environmental microbiology; water and wastewater treatment (wastewater is largest area of emphasis); and water resources.

The Environmental Science Program at Rutgers is the oldest of its kind in the United States, and deals with chemical and biological application to the solution of environmental problems. A specialized research group, Rutgers graduates from the Environmental Science Department are qualified for positions in the environmental field where expertise is needed for solutions of problems in which the air, water, solids, and pollution interact. Trained as multidisciplinary scientists, graduates may obtain positions as researchers and as high school and college instructors. They may also find positions within private industry working on waste problems as either industry employers or as consultants. Positions within government may be found in administration, enforcement, research, inspection, and control. Positions for the program's graduates exist at treatment facilities in the capacity of supervisor, director, analyst, technician, and operator.

The department's Environmental Science Laboratory is staffed with bench-oriented, problem-solving scientists in the pollution field Facilities are available for the solution of problems ranging from the most simple and practical to those requiring sophisticated analytical capabilities.

Seminars and a large non-degree short course program are conducted by Departmental faculty. Forty percent of the short course teaching load is in the areas of air, wastewater, water supply, and solid wastes. An environmental training center has been developed and one short course consists of seven days a week for air, wastewater, solid wastes and water supply training.

PROGRAM REQUIREMENTS

In order to enter the Environmental Science Program, prospective students must have a strong science-based background including chemistry, physics, biology, mathematics. No students without a chemistry background will be accepted into this program. Verbal and aptitude scores from the Graduate Record Examination are required and students must have a grade point average of 2.5 on a one point (high) scale.

In order to obtain the Master of Science degree, 30 credits of required course work (the research M.S. requires 24 credits plus a 6 credit thesis), which represents 50 percent of the selected program of study, must be fulfilled. Research is required to be in the major field of study, and is a twelve month program which requires an advisor. A candidate for the Doctor of Philosophy degree must normally spend not less than one academic year or two consecutive terms, excluding the summer session, as a full-time student in residence. A foreign language requirement for the doctorate is stipulated, and can be fulfilled either by examination or by course work (without credit), as approved by the program faculty. Forty-eight hours of course work plus twenty-four hours of research are required for fulfillment of the doctorate.

Research funding is available from the U.S. EPA, the National Science Foundation, the National Institute of Health, the Army Corps of Engineers, and the Department of Energy. The New Jersey Department of Environmental Protection and private industry also fund research concerning waste problems associated with air, water and solids pollution.

A variety of financial aid is available to graduate students and include research contracts, training contracts, industrial fellowships, teaching assistantships, coadjuncts and loans. The Danforth, Woodrow Wilson and Ford foundations offer fellowship programs for graduate students. The National Science Foundation offers graduate fellowships for beginning graduate students. Various publicly and privately sponsored fellowships include stipends ranging from $2,000 to over $5,000 a year and usually cover remission of normal tuition charges, including six summer credits. Teaching and graduate assistantships provide salaries beginning at about $3,969 or year with remission of tuition charges for both the fall and spring terms, plus an additional remission allowance (6 credits) for optional summer study. Assistants are usually required to spend up to fifteen hours per week on their jobs, whether in teaching or research.

CURRENT FACULTY, STUDENTS, GRADUATES

Twenty faculty members contribute to the teaching and research conducted by the Environmental Science Department. Only twelve faculty are involved in full-time teaching activities and fourteen staff teach the Department's courses. Fourteen staff members are involved in research activities.

There are currently 130 students enrolled in the Environmental Science Program and 70 are full-time students. Ninety of the students are male and forty are female (there are no female part-time students). Officials estimate that approximately 40 students annually receive degrees, on the average. Enrollment appears to be steadily increasing in the Environmental Science Department over the past several years.

All those graduating from the Department find employment directly related to their training. Approximately 35 percent of recent graduates find private sector industrial and consulting positions. Another fifteen percent obtain teaching positions within academia and the remaining 50 percent find public sector jobs. Many employers call the Department seeking to employ graduates from the program and this is considered by program officials to be an excellent method of finding employment.

PROGRAM PROJECTIONS

Because of recent rising enrollment trends additional faculty in the chemical and toxicity specialty areas may be recruited within the next five to ten years. Expansion of staff often takes a great deal of time because of the requirement of justifying growth. Program officials find that because of the complexities and work to be performed in this field, the present staff could be easily doubled in size.

The Environmental Science staff has considered developing Master's degree programs in environmental health and occupational health (industrial hygiene). Because the Rutgers program currently is stronger in the pollution sciences than others, wastewater aspects relating to health problems would be emphasized. Recent research has indicated that environmental and occupational health fields have been largely overlooked. Fields such as toxicology and epidemiology are needed to study the effects of low level pollution that is concentrated in the environment because they impact on man. Rutgers is uniquely situated to study such effects because eleven percent of the chemical industry in the nation is located in New Jersey. There is an unlimited potential for expansion in both teaching and research in the chemical and toxicity fields. To adequately begin research in this area, the Rutgers program would have to double its present staff and all present programs should be expanded in a sophisticated direction.

COURSE DESCRIPTION

(the following is a partial listing of courses offered)

Graduate courses 16:375:

501 Waste Treatment I: Sewage Treatment - Physical, chemical and biochemical processes utilized to treat municipal wastewaters. (3 s.h.)

502 Stream Sanitation - Principles of biological stabilization of pollution materials in streams; factors influencing atmosphere reaeration; changes in biological populations in polluted waters. (3 s.h.)

503 Analytical Techniques in Environmental Chemistry - Theory and techniques of analytical procedures applicable to research in environmental science. (3 s.h.)

504 Waste Treatment II: Water Treatment - Chemical, physical, and biological factors affecting development of water supplies; water quality; municipal and industrial water treatment processes. (3 s.h.)

508 Application of Principles to Treatment Problems - Application of fundamental principles concerned in water purification and liquid and waste treatment processes to design and operation problems. (3 s.h.)

510 Pollution Microbiology - Bacteria as indicators of sanitary conditions; liquid and solid waste treatment processes. (3 s.h.)

517, 518 Principles of Environmental Science - Principles and interaction associated with air environment, water environment, and environmental health. (3 s.h. each semester)

524 Source Control of Atmospheric Pollution - Principles, operation, performance, and application of methods and devices to control aerosol and gaseous emissions. (2 s.h.)

525 Principles of Solid Waste Management and Treatment - Solid waste problems in the municipal, industrial, and agricultural areas. (3 s.h.)

526 Limnology of Urban and Suburban Waters - Study of waters stressed by population, development, wastes. (3 s.h.)

INSTITUTION: SAM HOUSTON STATE UNIVERSITY

PROGRAM: Environmental Science

DEPARTMENT: Environmental Sciences (Division)

DEGREE: Bachelor of Science (B.S.) in Environmental Science

CONTACT:
Dr. James R. DeShaw
Associate Professor, Biology
Sam Houston State University
Huntsville, Texas 77340
(713) 295-6211 x2292

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The interdisciplinary Bachelor of Science degree in environmental science was established at Sam Houston State University in 1970. Program emphasis is on the sciences and mathematics.

The graduates of this program enter occupations in health, environmental and analytical fields. Employers include city, county, state and federal agencies. The petrochemical industries of the Gulf Coast are also major employers of these program graduates. Graduates entering these industries are utilized in areas of research, waste treatment, surveillance and quality control. Historically, these students have chosen a career path upon completion of the baccalaureate degree.

PROGRAM REQUIREMENTS

Although there are no special requirements for entrance into the environmental sciences program, students entering at the third year must have completed the first two year schedule of courses. Therefore, early identification of this program as the major would be helpful to the student.

Requirements for the first two years include completion of the following: 23 semester hours in English, history, government and physical education; 28 semester hours of chemistry, physics and mathematics; and, 15 semester hours in biology, geoscience, and environmental science.

During the third and fourth years the student must complete 62 semester hours of course credit which include: 15 semester hours of government, economics and humanities electives; 10 semester hours of chemistry; 20 semester hours of chemistry; 20 semester hours of biology and environmental sciences; and, 17 semester hours of restricted electives from the areas of agriculture, biology, chemistry, geography, geosciences or computer sciences.

An internship program is being developed but is not, at present, part of the requirements for completion of the baccalaureate degree in environmental sciences.

CURRENT FACULTY, STUDENTS, GRADUATES

Current faculty members include three full-time teaching personnel. All have achieved their Doctor of Philosophy degree and have conducted research in appropriate areas.

The student enrollment, at present, totals 35. Of the 35 total students, 28 are male and seven are female. Approximately 83% of the students are on some form of scholarship.

Graduates have averaged approximately 12 per year over the last three years. Approximately 25% of these graduates continue their education in pursuit of higher degrees. The University of Houston, Texas A & M and Rice University are the usual recipients of the continuing students.

PROGRAM PROJECTIONS

Long range plans for this program include growth in both student enrollment and faculty. By the end of 1978 the faculty is anticipated to have increased by one part-time environmental science teacher.

Program changes include the addition of an industrial hygiene course and a summer internship program which is still in the formative stages. An energy course from the physics department may be added to the restrictive electives.

COURSE DESCRIPTION

EnvSci 147 Environmental Science - A general course designed to cover all areas relating to contemporary ecological problems. (4 s.h.)

EnvSci 330 Legal Aspects of Pollution Control - A study comparing various state and federal laws with particular emphasis on the State of Texas statutes will be conducted. Nature of evidence for prosecution under these laws will be considered. (3 s.h.)

EnvSci 341 Instrumentation - Theory and practice of analytical methods used in the field of Environmental Science. (4 s.h.)

EnvSci 343 Water Supply and Wastewater Disposal - Water supply, development, treatment and distribution; wastewater collection and treatment; water purification and reuse; and the chemistry and ecology of aquatic systems are studies. (4 s.h.)

EnvSci 440 Air Pollution - An indepth study of the sources of air pollution is made. Sampling procedures and the chemical analysis required for identification of pollutants are studied. Control methods for the restriction of air pollution are outlined. (4 s.h.)

INSTITUTION: SLIPPERY ROCK STATE COLLEGE

PROGRAM: Environmental Studies (Interdisciplinary)
DEPARTMENT: School of Natural Sciences and Mathematics
DEGREE: Bachelor of Science in Environmental Studies

CONTACT: Murray A. Shelgren, Professor
Environmental Studies Program
Slippery Rock State College
Slippery Rock, Pa. 16057

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This interdisciplinary Environmental Studies Program at Slippery Rock State College was initiated in 1971 to prepare students for technical and administrative positions in industry, city and state health departments, planning commissions, and state and federal environmental agencies. The program is also designed to prepare students for graduate studies in environmental sciences. A systems approach is taken in instruction relating to chemical, physical and biological measurements in the environment. Recent graduates have obtained jobs as researchers, industrial hygienists (air sampling and monitoring), water pollution control engineers, air pollution engineers, aquatic biologists, environmental engineers, sewage plant operators, and sales and technical representatives.

The program utilizes fully equipped laboratories with atomic absorption spectrophotometers, microbiological, stack sampling and other related equipment. The laboratories in the departments of Biology, Chemistry and Geology are available to the students as well as the facilities of the Computer Science Department. The aquatic laboratory contains electroshocks and all other standard aquatic sampling equipment. A twenty-five foot pontoon boat has been set up as an aquatic and two sixteen foot runabouts are also at a biological field station on a 3,000 acre lake in a 15,000 acre park located nearby. Field trips are also taken to Lake Erie and other locations within a one hundred mile radius of the college. Approximately fifty percent of the program's courses involve field trips and the use of laboratory equipment in the field is an effective teaching tool.

PROGRAM REQUIREMENTS

Students must meet the entrance requirements of the college in order to enter the program. Transfer students from other science areas as well as transfers from junior colleges are also accepted.

A total of 128 semester credits are required for graduation and a student may elect with Track 'A' Air and Water Pollution or Track 'B' Ecological Planning. Common requirements for both tracks include a seminar, a research methods course, a field problems course, and two computer languages or equivalent courses. A three semester hour field problem for the Air and Water Pollution major is also required. courses, sixteen hours of elective courses, twenty hours of related courses and six hours of suggested courses are also part of the curriculum. Incorporated are biology, chemistry, geography, economics and mathematics courses.

Although there are no specific financial aid grants available through the Environmental Studies Program, the Pennsylvania Higher Education Assistance Agency provides State Grants, State Guaranteed Loans, and State Student Employment funds. Other normal federal programs such as the Supplemental Educational Opportunity Grant Program are also available to students.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of fourteen faculty members from nine departments contribute to the teaching of the courses offered in this interdisciplinary program. Two each of the faculty are from the biology, geology and chemistry departments and eight are from six other departments. However, only four professors teach the bulk of the courses which are the heart of the program.

There are currently fifty students enrolled full-time in the Environmental Studies Program and between ten to twenty percent are females. Approximately eight to ten students graduate with the Bachelor of Science degree annually. The number of students enrolled in the program has been steadily increasing in recent years, however, class size has remained small.

About twenty percent of the graduates have continued at other educational institutions for advanced degrees. Most of the students continuing their education are supported by their employers in continuing into sanitary engineering or public health programs offered by the University of Cincinnati or the University of Pittsburgh.

The College has had a 93 percent success rate in placing students in their field. About 5% find jobs in a related field and two percent in an unrelated field. Most (90%) find jobs with consulting firms and few (5%) find jobs with governmental agencies or other types of employers. Assistance in obtaining employment is provided by the College's Placement office and three faculty member's contacts with private firms.

PROGRAM PROJECTIONS

Although there are no current plans to develop new programs in this area by the college, the Environmental Studies Program is being modified and upgraded. It is likely that enrollment will increase and an engineering orientation (electronics, physics) will be taken. The current emphasis has been with Chemistry and Biology using "Standard Methods for the Examination of Waters and Wastewaters" as a central core. For example, a radiation course will be incorporated in future curriculums instructing basic techniques. Because of a current tight fiscal budget, the hiring of additional faculty is not anitcipated. In sum, the Environmental Studies Program will expand in a sense in that current courses will be upgraded and a certain reshuffling will be undertaken to meet employer needs.

COURSE DESCRIPTION

BIO 305 Aquatic Plants - Emphasis on the productivity of aquatic plants and their importance as indicator organisms. (3 s.h.)

BIO 306 Aquatic Animals - Emphasis placed on the productivity of aquatic animals and their importance as indicator organisms. (3 s.h.)

BIO 105 Environmental Biology - An introduction to ecological principles and concepts with an examination of the contemporary environmental problems. (3 s.h.)

CHEM 370 Water Pollution - Water quality assessment and water quality problems will be examined both in lecture discussions and in laboratory or field situations. (4 s.h.)

CHEM 430 Industrial Pollution Control Engineering - Economic and technical problems will be discussed as related to the abatement of harmful discharges from industrial sources. Systems analysis will be employed in the examination of engineering solutions. (3 s.h.)

GEOG 135 Environmental Problems - An introduction to some of the more crucial problems which arise with the environment, and the alternative solutions which are available. (3 s.h.)

GEOG 235 Resource Conservation - The utilization of the nation's resources, the need for conservation, the prevention of waste, and the problems of instituting wise conservation programs. (3 s.h.)

REC 340 Environmental Resource Analysis - A study of the principles and techniques of environmental resource analysis, landscape and scenery classification, and procedures for environmental quality and impact analyses. (3 s.h.)

Other courses:

GEOL 360 Water Resources - A study of the occurrence and movement of water and man's attempt to preserve this basic resource. (3 s.h.)

GEOL 451 Environmental Geochemistry - A study of the theory and applications of the role of the aqueous sedimentary interface equilibria and environmental pollution. (3 s.h.)

HSE 444 Epidemiology - The study of the principles and conditions of disease including agent, host and environmental factors. An overview of patterns of disease occurrence and the nature of epidemiological research. (3 s.h.)

BIOL 210 Medical Microbiology - The study of pathogenic microorganisms to include taxonomy, structure, biological activities, host defense mechanisms, disease transmission and states. (3 s.h.)

BIOL 304 Applied Microbiology - The study of those aspects of microbiology which directly affect human affairs with special attention given to environmental protection, agriculture, food technology and public health. (3 s.h.)

CHEM 340 Air Pollution - A study in the quality of the air environment. Air quality assessment and potential problems will be examined both in lecture discussions and in laboratory or field situations (includes ambient air testing, source testing, and industrial hygiene testing). (3 s.h.)

INSTITUTION: SPRINGFIELD TECHNICAL COMMUNITY COLLEGE

PROGRAM: Environmental Technology
DEPARTMENT: Environmental Technology
DEGREE: Associate in Science

CONTACT: John T. Donohue, Chairman
Division of Engineering Technologies
Springfield Technical Community College
Armory Square
Springfield, Massachusetts 01105

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This two-year Environmental Technology Program integrates two technical environmental options: Quality Technology, and Wastewater Treatment Technology. Formerly, these two options had separate curriculum structures but now are offered in one curriculum. The orientation is toward environmental engineering with the goal of training students to become para-professionals to assist an engineer. Their functions would include detecting and measuring pollution, installing control facilities, and operating purification facilities. It is anticipated that graduates would qualify for positions in industrial facilities, governmental agencies, municipal engineering offices, engineering firms, waste treatment plants and manufacturers representatives. This career-oriented program has not been designed to enable a student to transfer to a four-year college program. Springfield Technical Community College is an accredited member of the New England Association of Schools and Colleges.

The Department of Environmental Technology offers extensive facilities to assist students in receiving "hands-on" instruction. The program utilizes a complete chemical laboratory, a small model of an activated sludge filtration system, and air and water sampling equipment. Water samples are also picked up by the department from the Springfield waste treatment facility for analysis by students in the laboratory. In addition the program emphasizes its summer practicum between the first and second year in which students work forty hours a week for five weeks at treatment facilities (12 to 15) located within a 75-mile radius of the college.

PROGRAM REQUIREMENTS

In order to be considered for admission into the Environmental Technology Programs, prospective students must have had one year of chemistry and two years of algebra or its equivalent. Structured into the four semester curriculum (including the summer practicum) are sixty-eight credit hours of requirements. Included are courses covering the topics of process problems, environmental microbiology, technical report writing, treatment plant operations, industrial health and safety, water sample, analysis and control processes, systems maintenance, and air sample, analysis and control processes.

Most of the forms of financial aid available to students consist of the Basic Educational Opportunity Grant Program and Work-Study. Limited amounts are available from other funding sources.

CURRENT FACULTY, STUDENTS, GRADUATES

Two full-time faculty members contribute to the Environmental Control Technology Program of instruction. Currently (fall, 1977) the program has an enrollment consisting of twenty-six full-time male students, and approximately 10 students graduate annually on an average. Enrollment appears to be slowly increasing over the past few years.

Although this program is designed to be terminal, about eight to ten percent of the graduates continue on for higher education, although most find employment as waste treatment plant operators. For example, some of the program's graduates have changed their original career objectives midway through completion of the program and are enrolled in a general environmental science program (bachelor's) offered by the University of Maine. Although the college assists students in their employment search through its placement office, students often have more success securing jobs through participation in the summer practicum and responding to employers inquiries made to the department. Program officials estimate that 95% of the graduates obtain employment in their field and 5% in a related field Although most (80%) find government jobs, some students (20%) find jobs in the private sector, mostly in paper mills.

PROGRAM PROJECTIONS

The Environmental Technology Department is not anticipating hiring additional faculty members over the next five years as the program can accomodate more students with present staff. The program is flexible enough in orientation to be able to adapt to changing needs but current emphasis is on the development of the program's current resources.

The need to train wastewater treatment plant operators is expected to continue to increase although the need will begin to level off once the plants are built. However, department contacts do not anticipate that they are anywhere near a saturation point in the near future.

COURSE DESCRIPTION

6183 Wastewater Sample and Process - An investigation of the chemistry of domestic and industrial liquid wastes, their effects upon wastewater treatment plants and processes and the test procedures and techniques required for treatment plant operation. (3 s.h.)

6186 Environmental Studies - An introduction to environmental pollution, its effect on man and other living things and the basic principles of sanitation, treatment and control. (3 s.h.)

6190 Systems Operations and Maintenance - A study of wastewater treatment plant equipment with emphasis on diagnosis and repair and preventive maintenance programs. (3 s.h.)

6192 Treatment Plant Unit Operations I - An investigation of the physical and chemical processes utilized in the treatment of liquid wastes. (3 s.h.)

6197 Air and Water Quality Control Processes - A study of the processes utilized to reduce or eliminate pollution of the atmosphere. (3 s.h.)

6200 Air and Water Sampling and Analysis - An investigation of the equipment and techniques used in atmospheric sampling and of the instruments used to analyze the samples. (3 s.h.)

6201 Industrial Health and Safety - An investigation of the procedures and attitudes required so that man may safely work in the vicinity of industrial processes and equipment. (3 s.h.)

6234 Basic Instrumentation - A study of electrical, electronic and pneumatic basic and operating principles as applied to instrumentation used for the measurement and control of process variables. (3 s.h.)

6328 Treatment Plant Unit Operations II - An investigation of the physical and chemical processes utilized in the treatment of liquid wastes. (3 s.h.)

INSTITUTION: STEVENS INSTITUTE OF TECHNOLOGY

PROGRAM: Environmental Engineering, Environmental Science

DEPARTMENT: Mechanical Engineering

DEGREE: Master of Engineering (M.E.)
Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Fernando Sisto, Jr., Head
Mechanical Engineering Department
Stevens Institute of Technology
Castle Point Station
Hoboken, New Jersey 07030
(201) 792-2700

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Engineering and science students may enter an interdisciplinary program in Environmental Engineering/Science (also referred to as Environmental Systems) and complete an M.S., M.E., or Ph.D. in Environmental Systems under the supervision of an interdisciplinary advisory committee. Each graduate student completes a core of courses in environmental chemistry, mathematical models (including computer methods), fluid dynamics and thermodynamics, which are required for all environmental areas of specialization. In addition to the general environmental systems core, each student completes additional work to emphasize his/her specialization, such as water and water quality control, air pollution control, noise pollution control, thermal pollution control, and solid waste management and resources recovery. This program was initiated in 1978.

PROGRAM REQUIREMENTS

For admission to the program, students must meet the entrance requirements for graduate study at Stevens Institute of Technology. A bachelor's degree in engineering or science from an accredited college or university is required for admission. M.S. and Ph.D. degrees can be pursued by both engineering and science students; however, the M.E. degree can only be pursued by a student with an engineering degree.

The minimum requirements are thirty credits for the M.S. or M.E. degree. The maximum number of credits that may be transferred from other institutions is ten. A master's thesis is optional.

The minimum requirements for the Ph.D. degree are ninety graduate credits beyond the bachelor's degree. The maximum number of credits that may be transferred is thirty for the Ph.D. degree. The doctoral student must spend one year "in residence" performing research. Within one year after admission to the doctoral program or after receipt of the master's degree, whichever comes first, the student must take a qualifying examination. The preliminary examination must be taken at least one year before the degree is awarded. Foreign language requirements are left to the discretion of the interdisciplinary advisory committee. A doctoral student is officially admitted to candidacy when he/she has completed satisfactorily all requirements except the completion of the dissertation and the final examination in defense. A minimum of thirty credits is required for the Ph.D. dissertation.

CURRENT FACULTY, STUDENTS, GRADUATES

Eight faculty members, six full-time and two part-time, are currently participating in the environmental systems program. About one-third of the faculty time is devoted to research, with the remainder in teaching. Research funding in environmental systems is being sought from different governmental agencies, and industry.

Presently, there is one full-time graduate student in the M.E. program. As the interdisciplinary environmental program began in early 1978, there have not yet been any graduates.

PROGRAM PROJECTIONS

Program officials expect an expansion in the environmental systems program at both the master's and Ph.D. levels in the near future. The M.E. degree in environmental systems offered by S.I.T. will meet the general ECPD criteria for advanced level accreditation.

COURSE DESCRIPTION (SELECTED)

CE 74 Sanitary Engineering - An environmental engineering course oriented to the control of air, water, land, noise and thermal pollution. Topics covered are: sources and nature of pollution, pollution effects, control of communicable and certain noninfectious diseases, source and protection of water supply, prediction and dispersion of airborne effluents, pollution control technologies, solid waste handling and disposal, ventilation and air conditioning, radiation uses and protection, food protection, vector and weed control, pesticide use, energy and resources recovery and thermal pollution control in streams. Environmental analytical techniques are briefly introduced and practiced.

CE 75 Environmental Systems - Water supply and sanitation systems; water runoff and conservation; hydrology and stream flow; flow in pipes and open channels; networks; water treatment; water distribution; sanitary sewers; storm sewers; treatment plants;

CE 75 (Cont'd) - pumping and regulating chambers; biological processes; physical-chemical processes; field trips to local sites of interest.

MS 47 Ecology and Social Costs - Problems involving the interaction between the environment and selected areas of the economy are investigated with heavy emphasis on the collection and analysis of data; typical areas include: use of recreational land, recycling waste material, pollution control, evaluation of costs and benefits of environmental movements.

ME 113 Introduction to Nuclear Engineering - A development of the background necessary for nuclear engineering, beginning with a review of atomic physics and including radioactivity, nuclear reactions, neutron physics and elementary reactor theory, reactor dynamics and control, reactor types, metallurgy of reactor materials, heat transfer and fuel element design.

ME 133 Biological Treatment of Wastewater - Biological basis of wastewater treatment; river-wastewater treatment works analogy; population dynamics; food sources; aerobic and anaerobic systems; reaction kinetics and parameters affecting waste removal; fundamentals of mass transfer and gas transfer; trickling filter; activated sludge process; aerated lagoons; stabilization ponds; nitrification; dentrification; sludge concentration; aerobic sludge digestion; anaerobic sludge digestion, sludge conditioning; sludge drying, vacuum filtration; incineration; and ocean disposal. A biological treatment plant design project is included.

ME 134 Chemical and Physical Treatment of Water and Wastewater - A study of the chemical and physical operation involved in treatment of potable water, industrial process water and wastewater effluent; topics include chemical precipitation, coagulation, flocculation, sedimentation, filtration, disinfection, ion exchange, oxidation, adsorption, flotation, and membrane processes. A physical-chemical treatment plant design project is an integral part of the course. The approach of unit operations and unit processes is stressed. Physicochemical treatment are conducted.

ME 135 Sanitary Plumbing Systems Laboratory - Experimental and analytical treatment of problems of supply of potable water to residential and commercial buildings. Conveyance of wastewater in multistory and multiuse structures. Theoretical and practical bases of codes and design procedures. Aesthetic and economic considerations. Laboratory verification of theoretical concepts involved in design and analysis of systems. Analog modeling of supply and disposal systems.

ME 140 Origins and Analyses of Air Pollutants - Atmospheric and source emission testing of air pollutants; laboratory and field work involving sampling and testing for the concentrations of particulates, nitrogen oxides, hydrocarbons, carbon monoxide and sulfur dioxide in the atmosphere and in chimneys; stack

ME 140 (Cont'd) - emission testing for carbon dioxide and oxygen; dispersion models for air pollutants; national air quality standards, air quality criteria; federal and state laws, local ordinances.

ME 141 Air Pollution Control - Control of pollutant emissions from vehicles and from stationary industrial sources; particulates, nitrogen oxides, carbon monoxide, hydrocarbons, sulfur dioxide and others; cyclone separators, electrostatic precipitators, baghouse collectors, scrubbing, absorption, adsorption, afterburning, and others; combusion of fossil fuels and equilibrium concentration calculations; combustion modification and flue gas recirculation for pollutant emission control.

ME 145 Site and Environmental Planning - Assessment of the environmental impact of a proposed project; methods of analysis of environmental factors affecting a variety of projects through case studies; establishing a procedural guideling for making environmental impact statements; preparation of an environmental assessment report analyzing an environmental problem confronting a community in the New York-New Jersey metropolitan area.

ME 167 Acoustics - Fundamentals of vibration, plane wave, spherical waves, sources, receivers, resonators, ultrasonics, absorption, speech, hearing, noise, architectural acoustics.

ME 168 Acoustics Laboratory - Experiments illustrating principles, practices, instrumentation for acoustics; sources, receivers, absorption, standing waves, resonators, room acoustics, underwater acoustics.

ME 171 Noise Control - Behavior of sound waves in air; psychoacoustics; criteria for hearing conservation; criteria for noise and vibration in communities, buildings, and vehicles; sound and vibration transducers; field measurements; data analysis; architectural acoustics; noise control techniques; previous experience in acoustics is not required.

ME 173 Waste Heat Disposal - Methods of disposing of large quantities of low grade heat energy will be discussed. Included will be once through cooling with surface or submerged discharge into lakes, rivers, and estuaries; wet and dry cooling tower performance; spray canals and cooling ponds; methods of utilizing the energy, e.g., aquaculture, heating, agriculture.

ME 190 Environmental Law for Practicing Engineers - Review of laws regarding air, water and noise pollution. Role of engineer representing a company or the public before governmental agencies. Permit system, implementation plans, and other legal sanction. Site studies and environmental impact statements.

INSTITUTION: SYRACUSE UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Environmental Engineering

DEGREE: Bachelor of Science (B.S.)

CONTACT: Dr. James A. Luker
Dean, College of Engineering
Syracuse University
Syracuse, New York 13210
(315) 423-4341

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental engineering program is designed to provide a strong background in engineering sciences while also preparing engineers for evaluation and solution of environmental problems. It is a broad-based program which encompasses four areas of environmental concern: air, water, solid waste, and noise.

This program, which was initiated in 1971, allows students considerable flexibility in determining their own programs of study to meet their needs and interests. An interdisciplinary committee of faculty members from the various engineering departments directs the program and a faculty advisor from this committee advises each student in the development of an individual program. Support facilities for the program are the laboratories and facilities of the other engineering departments, principally civil and chemical.

PROGRAM REQUIREMENTS

Admission to the program generally requires a high school diploma and scores from either the Scholastic Aptitude Test or the American College Test. Transfer students from community colleges and other four-year institutions are encouraged, with few restrictions on the acceptance of transfer credits. It is generally required, however, that transfer students complete the environmental engineering courses at Syracuse.

A minimum of one hundred and twenty-six credit hours are required for completion of the program. Included are at least twenty-nine hours of engineering science and fifteen hours of engineering design. Although a student can specialize in a particular environmental area, at least one course must be taken in each of the four areas: air, water, solid waste, and noise. Two additional courses must also be taken in air or water. Three credit hours of independent study and three hours of environmental engineering design are also required.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of twelve faculty members participate in the environmental engineering program on a part-time basis. All have full-time assignments to other departments and conduct research in their primary departments.

There are currently forty-four students in the program, all full-time. A number are career change, coming from other disciplines such as biology or forestry. Officials indicated that approximately sixty percent of the students are in-state residents. Recruitment is done chiefly through the university and some students are receiving financial assistance through university scholarships.

Approximately twelve students per year graduate from the program and this figure remains fairly constant. About twenty-five percent of the graduates go on for further degrees and of the remainder, almost seventy-five percent find employment in the private sector. Graduates are placed through faculty contacts and the university's placement service.

PROGRAM PROJECTIONS

There is no expansion foreseen in the program or faculty for the near future.

COURSE DESCRIPTION (SELECTED)

CEN 511 Environment Monitoring Instrumentation - Experimental techniques of sampling and analysis of gaseous, liquid and solid waste. Principles and operation of modern instruments to measure very low concentration of air and water pollutants, including the evaluation of typical data. (3 s.h.)

CEN 545 Physiochemical Methods in Waste - General survey on the applicability of chemical engineering unit operations and unit processes in fluid waste treatment. Membrane process, including electrodialysis and reverse osmosis, IPC (Independent Physical and Chemical) process of waste treatment, coagulation, deep bed filtration, and carbon column operation. (3 s.h.)

CEN/MEE 547 Chemistry and Transport of Air Pollutants - Photochemical, thermal, and heterogeneous reactions of gaseous pollutants, transport equations, air pollution climatology, dispersion modeling and forecasting potential air pollution occurrences. (3 s.h.)

CEN 573 Principles and Design in Air Pollution Control - Fundamental principles of pollution control, design of control

CEM 573 (cont'd)
processes and equipment, criteria for selection of control processes and equipment for gaseous and particulate pollutants. (3 s.h.)

CIE 453 Water Resources - Occurrence, distribution, and statistical analysis of rainfall and river flow. Relationships of rainfall to runoff. Prediction of drought and flood frequencies and quantities. Surface and subsurface water storage. (3 s.h.)

CIE 454 Treatment of Water and Waste Water - A comprehensive study of the theories and applications of unit processes utilized in rendering water acceptable for domestic and industrial consumption and waste waters acceptable for discharge into receiving systems. (3 s.h.)

CIE 551 Sanitary Engineering Theory I - Theoretical basis for analytical procedures and for treatment of water and waste water. Laboratory determination of constituents. (3 s.h.)

CIE 553 Sanitary Engineering Theory III - General principles of sanitary microbiology, with special emphasis on the role of lower protists (bacteria and blue-green algae) in the ecology of streams lakes, water treatment, and waste water treatment processes. (3 s.h.)

CIE 558 Solid Wastes: Collection and Disposal - Composition of refuse; quantities produced by individuals and industries; collection equipment, methods and associated costs, type service, including contracts; financing and cost accounting; disposal problems, solutions, such as landfills, incineration, composting; combined disposal with industrial wastes. (3 s.h.)

CIE 561 Air Resources I - Occurrences, nature and properties, major sources and quantities of contaminants; ambient air concentration levels, community distribution patterns and control of air pollution. (3 s.h.)

MEE 483 Introductory Acoustics and Noise Control - Sound. Introduction to acoustics. Sound pressure level and ear response. Simple noise control. Field work: measurement of airport, traffic and office noise with mobile acoustics laboratory. (3 s.h.)

MEE 555 Combustion-Generated Air Pollution - Introduction to basic combustion mechanisms. Major combustion air pollution sources are investigated and design variables which affect emission levels analyzed. (3 s.h.)

MEE 565 Combustion Engineer Emissions - Role of motor vehicles in air pollution. Engineer operation, fuels. Emission formation in gasoline, diesel, and gas turbine engines. Federal test procedures. (3 s.h.)

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INSTITUTION: TEMPLE UNIVERSITY

PROGRAM: Environmental Technology (A.T.)
Environmental Engineering Technology (B.S.)

DEPARTMENT: Civil and Environmental Engineering Technology

DEGREE: Associate in Technology (A.T.)
Bachelor of Science (B.S.)

CONTACT: Dr. Frederick B. Higgins
Chairman of the Department of Civil and
Environmental Engineering Technology
Temple University
Philadelphia, Pennsylvania 19122
(215) 787-7816

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The College of Engineering Technology offers two degree programs relating to environmental pollution control; Environmental Technology and Environmental Engineering Technology. The Environmental Technology Associate degree curriculum is oriented toward the training of engineering technicians to perform environmental measurement and control tasks for either industry or governmental agencies. This program is accredited by the Engineer's Council for Professional Development and graduates are trained for positions as air pollution technicians, laboratory technicians, service technicians, technical representatives, and water quality technicians.

The Environmental Engineering baccalaureate curriculum is based on chemistry, biology, civil engineering, and chemical engineering aspects which would be most appropriate to study environmental quality deterioration and to the design of equipment or systems for pollution abatement and control. Students prepare for the practical application of control technology to pollution control and abatement. Students may select electives to emphasize engineering, social or management aspects. Graduates may obtain positions as project engineers with consulting companies in environmental control groups in industry, or in regulatory agencies.

The two programs utilize a wet chemistry laboratory for the analysis of environmental pollutants and an instrumentation laboratory which contains automated air and water pollution monitors. In addition, a bacteriological laboratory is available for students to use. Several pilot treatment plants are also available.

PROGRAM REQUIREMENTS

In order to be eligible for admission at Temple University sixteen units (one unit - one year) of acceptable high school work are required of which ten must include four units of English, two units of college preparatory mathematics, one unit of history, one unit of laboratory science and two units of a foreign language. College of Engineering Technology students are not required to satisfy the foreign language requirement but must instead present two additional units of mathematics and laboratory sciences.

The two-year Environmental Technology curriculum includes 66 semester hours of required courses plus an environmental field operations course (4 semester hours) during the summer between the second and third semesters. The four year Environmental Engineering Technology curriculum includes 124 credit hours of required courses over an eight semester period plus the summer field operations course.

The students participating in these programs can elect a cooperative educational arrangement as an option. Approximately three students participate each semester and the U.S. Environmental Protection Agency office in Philadelphia is the largest employer of Temple University's environmental students.

Although there are no specific departmental grants available to students as financial assistance, Pennsylvania has grants available entitled Pennsylvania Higher Education Agency and Basic Education Opportunity Grants and other forms of federal grants are available.

CURRENT FACULTY, STUDENTS, GRADUATES

Only two faculty professors are engaged in teaching Temple University's environmental courses offered in the two degree programs. However, other full-time faculty in other departments also teach major courses in noise control, solar energy, environmental impact assessment and energy and environment.

There are currently 64 full-time students (nine females) and twelve part-time students enrolled in the baccalaureate program. Eight students (3 females) are enrolled in the associate program. Approximately fifteen baccalaureate students and one to two associate degree students graduate annually. The baccalaureate program has been increasing steadily but not as rapidly as has been expected by program officials. Enrollment in the associate degree program has been low and appears to be declining.

Almost all of the associate degree students transfer into the baccalaureate program. However, only ten to fifteen percent of the Environmental Engineering Technology graduates continue for advanced degrees. Because of a state and city policy of hiring engineers and not technicians, few Temple graduates work for city or state environmental agencies. The U.S. EPA Regional Office in Philadelphia is a consistent employer of Temple graduates (2 each year). Recent graduates have also found employment with local water treatment equipment manufacturers and sales engineering firms (as technical representatives). Because the unavailability of public agency jobs in the Philadelphia area exists, eighty percent find private sector employment.

PROGRAM PROJECTIONS

Temple University plans to offer its first baccalaureate engineering degree program in the fall of 1978. Many of the environmental courses will be incorporated in the engineering curriculum. One day-adjunct instructor and six to seven evening adjuncts are expected to be recruited in the near future to teach energy and environment, air pollution, environmental impact preparation, and computer modelling courses. All will have engineering backgrounds and will teach specific courses on an adjunct basis. The Environmental Technology programs are acquiring a unit operations laboratory in a new building during 1978 and air/industrial hygiene will be taught in its facilities. The laboratory will be equipped with pilot scale water and wastewater treatment plants with capacities of between one-half to one million parts per million capacity.

As baccalaureate enrollment appears to be increasing steadily, a B.S. in Engineering Science with no departmental sponsor will be initiated. Ultimately an environmental engineering major will be developed, but no departmental degrees will be offered.

COURSE DESCRIPTION

10 Introduction to Environment - Evaluation of environmental conditions. (3 s.h.)

11 Energy & Environment - The effects of energy development and use on environmental quality. (3 s.h.)

13 Environmental Chemistry - Basic principles of chemistry and stoicheometry as they relate to environmental pollution measurements and chemical treatment. (3 s.h.)

17 Sanitary Chemistry & Microbiology - Wet analysis of environmental importance; sampling; data handling; standard test; microbiology. (3 s.h.)

24 Environmental Instrumentation - Optical, electrochemical and instrumental methods of analysis; environment applications. (3 s.h.)

31 Pollution Control Processes - Liquid and gas properties of importance in environmental control operations; sedimentation, filtration, membrane processes, adsorption, ion exchange, chemical treatment. (3 s.h.)

33 Environmental Field Operations - Field aspects of environmental engineering: Air and water sampling, stack sampling, bioassay and environmental aspects of planning. (4 s.h.)

110 Air Pollution Control Systems - Principles of design and operation of municipal and industrial wastewater treatment plants. (3 s.h.)

113 Solid Waste Management - Refuse collection and disposal incineration; landfill; composting; recycling; special wastes. (3 s.h.)

115 Water Treatment - Chemical and physical methods of treatment of water supplies. (3 s.h.)

116 Environmental Regulations - View of environmental regulations at the federal, state and local levels. (3 s.h.)

120 Environmental Systems Design - The practical design of pollution control systems in the areas of air, water, solid waste, industrial hygiene and noise. (3 s.h.)

210 Environmental Planning - Planning as a factor in minimization of environmental impact and on preparation of environmental impact statements. (3 s.h.)

211 Energy Resource Development - Current energy sources, available resources and methods of development. (3 s.h.)

390 Independent Study in Environmental - Student permitted to study a regular course on his own during the semesters the course is not offered, enabling student to meet prerequisite or graduation requirements. (2-4 s.h.)

398 Independent Research - Student will be assigned a research project with the approval of the department chairman and conducted under the supervision of a faculty sponsor. (2-4 s.h.)

INSTITUTION: TEXAS A & M UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) in Civil Engineering

CONTACT: Dr. Harold William Wolf
Professor, Civil Engineering
Texas A & M University
College Station, Texas 77843
(713) 845-3011

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering is an integral component of the Civil Engineering Department, College of Engineering, at Texas A & M University. The programs date back to the 1920s although substantial changes have occurred since that time. At Texas A & M, environmental engineering is a multidisciplinary program. These broad-based programs allow students to emphasize surface and groundwater quality, water resources, air quality control, and management of solid wastes. Close cooperation is maintained with other departments in order to insure the appropriate interfacing components of the overall program structure.

The university maintains modern and fully equipped laboratories. Within the civil engineering department, over 15,000 square feet of space is allocated to environmental engineering laboratories. Faculty and students also utilize the new waste treatment plant for research and instruction. The Division of Environmental Engineering operates a pilot treatment plant and a research laboratory at the new treatment plant site.

PROGRAM REQUIREMENTS

The requirements for the Master of Science degree (M.S.) include successful completion of at least 32 semester hours of academic course work past the baccalaureate degree, of which six may be in CE 691 (thesis). All students must complete a statistics or mathematics course from Stat. 601, Math. 411, 417 or 601. Additional requirements vary according to the particular concentration which may be: (a) water quality; (b) air quality; (c) solid waste management; or (d) environmental systems. Particular requirements include the following:

	(a) water	(b) air	(c) s.w.	(d) en.sys.
CE 406	x	x	x	x
CE 603	x	x	x	x
CE 604	x			x
CE 605	x	x	x	x
CE 607	x	x		x
CE 608		x	x	x
CE 610				
CE 611				
CE 680			x	
CE 681	x	x	x	x

In addition, water quality students must take six semester hours in two sciences (microbiology, organic chemistry, physical chemistry), and one course from CE 606, 610, or 611. Air quality and solid waste management students must take six semester hours in related technology or science areas other than environmental engineering. Environmental systems students must complete six semester hours in computing science or related mathematical modeling.

In order to qualify for the Ph.D., the student must have obtained the M.S. degree. Doctoral students are required to accomplish the following: (1) demonstration of competence in some form of computer language; (2) satisfaction of master's level course requirements; (3) completion of a minimum of 12 semester hours outside civil engineering; and, (4) completion of all special requirements as detailed by the Civil Engineering Department.

CURRENT FACULTY, STUDENTS, GRADUATES

The faculty currently associated with the Texas A & M environmental engineering graduate programs, consists of 15 personnel. These personnel also allocated part-time to other civil engineering programs. Responsibilities of these personnel include: 5.43 teaching; 8.93 teaching; and .63 administation.

The enrollment at present includes 15 full-time graduate students. There are 13 male and one female master's level students, and one male doctoral student. The enrollment, at present illustrates a slight increase in master's students, and a decrease in doctoral students since 1973.

Graduates of this program have also decreased slightly over the last few years. During the last academic year (1976-77) three students earned the Master of Science and two students were awarded the Doctor of Philosophy degree.

Approximately 2% - 3% of the master's students, annually elect to pursue the doctoral degree. Historically, these students have chosen Rice University and the University of Texas for their continued education.

PROGRAM PROJECTIONS

Growth in the faculty will include five additional Ph.D. personnel (microbiology, chemistry and biology) within the next two years. Enrollment growth is also anticipated.

COURSE DESCRIPTION

CE 603 Stream Quality - Physical, chemical, radiological and biological properties of streams, impoundments, reservoirs and estuaries and the interrelationships of these properties; local, state, regional and federal water quality standards. (3 s.h.)

CE 605 Experimental Analysis in Environmental Engineering - Theory and practice of analytical methods used in the environmental engineering field. (3 s.h.)

CE 606 Design of Wastewater Treatment Systems - Application of the theories of unit operations and unit processes to design wastewater treatment systems for domestic and industrial wastes. (3 s.h.)

CE 607 Environmental Analysis for Urban Areas - Analysis of urban problems, including air pollution and environmental engineering, problems affecting urban and suburban areas. (3 s.h.)

CE 608 Environmental Design for Urban Areas - Design of environmental engineering projects related to urban problems including air pollution. (3 s.h.)

CE 609 Simulation of Water Resources Systems for Numerical Analysis - Digital methods for simulating runoff from river basins. Numerical evaluation of stream quality variation. (3 s.h.)

CE 610 Industrial Wastes - Theory of industrial processes which create industrial wastes. (3 s.h.)

CE 611 Design of Potable and Industrial Water Systems - Application of theories of unit operations and unit processes to the design of systems for treatment of water for domestic and industrial uses. (3 s.h.)

CE 624 Environmental Effects of Transportation Systems - Interaction of traffic facilities with the adjacent land. (2 s.h.)

CE 626 Roadside Safety Design - Fundamental concepts of designing safety into roadways. (3 s.h.)

CE 627 Hydrology - Weather and hydrology, precipitation, streamflow analysis, subsurface water, streamflow hydrographs, streamflow routing, computer simulation of streamflow, probability studies, sedimentation. (3 s.h.)

CE 664 Water Resources Development - Planning and measurement concepts for control, conservation and utilization for water resources. (3 s.h.)

CE 681 Seminar - Reports and discussion of current research.
(1 s.h.)

INSTITUTION: THE COOPER UNION

PROGRAM: Integrated Master's Program in Engineering With Concentration in Environmental Engineering

DEPARTMENT: School of Engineering

DEGREE: Master of Engineering (M.E.)

CONTACT: Dr. John L. Bove
Professor of Chemistry and Environmental Engineering
The Cooper Union
Cooper Square
New York, New York 10003
(212) 254-6300

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The integrated engineering program at Cooper Union offers students a concentration in environmental engineering which is actually a minor in one of the four traditional engineering disciplines available: chemical, civil, electrical, and mechanical engineering. The integrated program was initiated in 1975. A unique feature of Cooper Union is that no tuition is charged. The School is supported by an endowment.

This program is five years in length and integrates work at both the undergraduate and graduate levels. Students are required to major in traditional engineering discipline and to elect a minor in a field substantially different from the major. Curricula is based on intense study in the sciences, mathematics, and interdisciplinary fundamentals of engineering. Upon completion of appropriate bachelor's degree requirements, a student receives the Bachelor of Engineering degree as well as the M.E.

Program support is provided by the laboratory facilities of the School of Engineering and the Institute for Energy and Environmental Management. This Institute conducts research on long-range problem solutions for industry and local governments.

PROGRAM REQUIREMENTS

Admission to the program requires a high school diploma with a minimum of sixteen units completed in the following summer: four units of English, two units of history and social studies, three and one-half units of mathematics, one unit of physics, one unit of chemistry, and four and one-half units of electives. In addition, applicants must take the Scholastic Aptitude Test along with achievement tests in physics or chemistry and math.

Degree requirements include a minimum of one hundred and seventy credits. The requirements in specific subject areas vary according to the major field of study. Each student is required, however, to take at least twenty-four credits in humanities and social studies, five credits in interdisciplinary engineering, and fifteen credits in the minor field of study. A thesis or project in the major or minor field of study, equivalent to a maximum of six credits, is also required.

Within the environmental engineering concentration, students are required to complete courses in environmental fundamentals, air pollution control systems, water resources engineering, and two advanced technical courses of their choosing.

CURRENT FACULTY, STUDENTS, GRADUATES

Program faculty consists of ten part-time members and another ten adjunct members who are also involved on a part-time basis. Their primary function is teaching and although no credit is given for research, all do environmental research through the Cooper Union Research Institute. Research has been funded by the City of New York, EPA, and private sources.

Because the program and the environmental concentration began in 1975, students will be selecting their minor concentrations during the current school year. Officials estimate that about twenty-five to thirty students will elect environmental engineering. Approximately eighty percent of the students come from the New York City area with most of the remainder coming from New York State and New Jersey. No recruitment is done for the program since there are always more applicants than can be accepted. Student financial assistance is not a major consideration since there is no tuition charge. Until 1977 the program did, however, receive an EPA training grant.

Although no specific information is available on program graduates, officials indicated that about twenty-five graduates each year are anticipated. Of current engineering graduates, approximately seventy-five percent work in the private sector and the remainder in government agencies. Placement is generally done by the school's placement office.

PROGRAM PROJECTIONS

A curriculum study is currently being conducted within the School of Engineering on the feasibility of integrating humanities into the engineering program. No changes are anticipated prior to completion of this study in 1979.

COURSE DESCRIPTION (SELECTED)

EID 140 Environmental Fundamentals - The nature of the environment-air, water, land and solar radiation interrelationships. Demographic trend, material and energy demands and the environment. Sources of environmental pollution and legal activities toward their control. Factors affecting pollutant levels in the atmosphere. (3 s.h.)

EID 141 Air Pollution Control Systems - System design for particulate, gas and vapor recovery. Study of dynamics of particulate behavior in fluid stream, Brownian motion, interception, inertial impact; target geometry and effects; nucleation and particle growth; energy consumption and collection efficiency. Other topics. (3 s.h.)

EID 142 Water Resources Engineering - Problems in conservation and utilization of water. Hydrologic techniques. Surface water and ground water supplies. Water transmission and distribution. Problems of water pollution, groundwater flow, and drainage. (3 s.h.)

EID 341 Environmental Impact Analysis - The purpose, contents, and resulting actions of an environmental impact statement (EIS). Consideration will be given to the proper protocol for preparing an EIS. Some time will be spent reviewing the role of the U.S. EPA in the evaluation of the EIS, and some of the recent trends associated with state and local government roles. (3 s.h.)

EID 342 Environmental Modeling and Simulation - Consideration of various modeling methodologies including: rollback, black box models, k-theory, similarity theory; other topics of current interest. (3 s.h.)

EID 343 Air Pollution Instrumentation and Measurement - This course covers operation and calibration of monitors for particulate and gaseous air pollutants, analysis of fuel oil samples for sulfur content, analysis of gasoline samples for lead content and vapor pressure. (3 s.h.)

EID 344 Environmental Law and Planning - A survey of legislative, administrative and judicial controls that affect the engineer and scientist in relation to air, water and other forms of pollution abatement and control. (3 s.h.)

EID 443 Hydrology - Hydrology of the water cycle related to air mass movement, precipitation, evaporation, and other topics. (3 s.h.)

INSTITUTION: THE PENNSYLVANIA STATE UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)
Master of Engineering in Environmental Engineering (M.E.E.E.)
Doctor of Philosophy in Environmental Engineering (Ph.D.)

CONTACT: Dr. Raymond E. Untraver, Head
Department of Civil Engineering
212 Sackett Building
The Pennsylvania State University
University Park, Pennsylvania 16802
(814) 865-8391

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Engineering Program at Penn State was first initiated in September, 1972. It is really an expansion of the Bachelor of Science degree in Sanitary Engineering, a program first started in 1908. At the undergraduate level, the program is designed to provide a basic foundation in engineering supplemented by specialized study in the areas of air, water and solid waste, and radiological protection. All students in the program will receive instruction in one of them by selecting an option for his or her last four terms. A general option is available for those students who wish to postpone specialization to a graduate level program. The major is an interdisciplinary one within the College of Engineering and it is administered by the Department of Civil Engineering. Continuous liaison is maintained with the College of Earth and Mineral Sciences.

The Environmental Engineering degrees at the graduate level are administered entirely by the Civil Engineering Department. The graduate program can also provide specialization in the areas of air, water, or solid waste.

Most students obtain employment with consulting engineering firms, regulatory agencies and industry.

Extensive laboratory facilities are provided for Environmental Engineering in the departments of the two colleges involved with research and instruction. The Department of Civil Engineering has laboratory facilities for instruction and research in the areas of water, wastewater and solid waste. The Department of Mechanical Engineering has laboratories in the area of air pollution control. Additional research and laboratory space is available in the Center for Air Environment

Studies. The Department of Nuclear Engineering operates the Breazeale Nuclear Reactor with laboratory facilities in the area of radiological protection. Facilities are avsilable in the College of Earth and Mineral Science laboratory in the areas of geochemistry, hydrogeology, and mineral processing.

PROGRAM REQUIREMENTS

Candidates with a baccalaureate degree in a field of engineering are eligible for the advanced degrees. The degree should be from an institution accredited by the Engineer's Council for Professional Development. In order to enter the College of Engineering as an undergraduate, three units of English, three units of mathematics (1½ units of algebra, 1 unit of plane geometry, and ½ unit of trigonometry), one unit of science, and eight other units are required during high school preparation.

For the B.S. degree in Environmental Engineering, 140-143 credits are required, depending on the option selected. Required are 67-68 baccalaureate degree requirements, 51 credits of major requirements and 22-24 credits for the option (general, 22; air, 22; radiological, 24; and water and solid waste, 23).

Requirements for the Master of Science degree in Environmental Engineering include 30 semester credits of course work (20 to be completed in residence), a thesis, and a twelve month completion period. No language proficiency is required.

The Master of Engineering degree in Environmental Engineering requires completion of 30 credits in residence with 27 credits in course work and 3 credits directed to the Engineering Report.

The Doctor of Philosophy degree in Environmental Engineering requires completion of a candidacy exam, language exam, comprehensive exam, dissertation, and final oral exam.

A five-year work study program in environmental engineering is available and includes alternating periods of study and employment. Two years of engineering experiences and money to offset educational costs are acquired by students admitted to this program.

At the graduate level, one and one half departmental graduate assistantships are available. Sponsored research projects are the funding sources for additional assistantships.

CURRENT FACULTY, STUDENTS, GRADUATES

Ten full-time faculty members make up the interdisciplinary faculty which teach the undergraduate level courses. Eight are from Civil Engineering (5 water quality; 3 water resources hydrology); one is from Mechanical Engineering (air pollution); and one is from the Nuclear Engineering Department (radiation). Six professors from the

Department of Civil Engineering make up the graduate Environmental Engineering staff. They devote about 70 percent of their time to teaching and 30 percent to research activities. Most research funding is from industry although the City of Philadelphia does provide some funding for research.

There are currently (Fall, 1977) a total of 130 (12-15 female) full-time students enrolled in the undergraduate program. Included are two to three part-time co-op students. At the graduate level, 19 students (1 female) are enrolled in advanced degree programs. An average of 23 undergraduates and eight graduates annually earn degrees from the Environmental Engineering program.

Approximately 20-25 percent of the undergraduates continue on for advanced degrees. Most master's students continue on to other educational institutions for doctorates. In previous years, most (60 percent) of the master's students were continuing on for doctorates at Penn State. Eighty percent of the program's graduates have obtained employment in their field and 70 percent have found jobs in the private sector, mostly with consulting engineering firms. Consulting engineering firms make an active recruitment effort of Penn State students. Only 30 percent of the program's graduates have found positions in government agencies.

PROGRAM PROJECTIONS

The Environmental Engineering Program is now at maximum capacity and little additional growth is projected. No change from the current emphasis is expected. During the last two to three years, the enrollment has increased greater than what was anticipated. Financial constraints prevent the hiring of any additional staff members for the program.

COURSE DESCRIPTION (SELECTED)

Biol 410 General Limnology - Organisms found in inland waters; biological factors affecting their distribution and relationship; intensive studies of our local streams. (3 s.h.)

Biol 435 Ecology of Lakes and Streams - Physical, chemical, and biological characteristics of freshwater environments, with special emphasis on factors regulating productivity in freshwater ecosystems. (3 s.h.)

Bio 481 Aquatic Botany - Identification, collections, and relationships of higher aquatic plant groups; field study of habits. (3 s.h.)

CE 51 Engineering Hydrology - Water sources and losses in nature; effects of precipitation, evaporation, and subsurface percolation on streamflows; flood prediction, water resource management.(2 s.h.)

CE 70 Water Pollution Control -Quantity and quality of municipal and industrial water and waterwater. Unit operations and treatment processes for water pollution control. (3 s.h.)

CE 371 Water and Wastewater Transport Systems - Water storage and transmission; design of water distribution and sewerage systems; pumps and pumping systems. (2 s.h.)

CE 451 Advanced Hydrology - Recent advanced in deterministic, stochastic, and urban hydrology. (3 s.h.)

CE 471 Environmental Sanitation - Public health engineering applications related to communicable diseases, water supply, wastewater disposal, solid wastes, air pollution, food, vectors, and radiation. (3 s.h.)

CE 472 Water Pollution Control Processes - Principles and design of unit operations for water; domestic and industrial wastewater treatment; equipment selection and application. (3 s.h.)

CE 473 Water Quality Management - Water quality criteria and standards; fate and impact of pollutants in aquatic systems; technology available for wastewater renovation. (3 s.h.)

CE 476 Solid Waste Management - Solid waste collection, salvage and disposal techniques for municipalities and industries; cost analyses; legislation; management; financing; design optimization. (3 s.h.)

CE 570 Physical Chemical Treatment Processes I - The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. (2 s.h.)

CE 571 Physical Chemical Treatment Processes II - The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. (3 s.h.)

CE 572 Biological Treatment Processes - The theory of biological processes used in the treatment of municipal and industrial wastewaterss. (3 s.h.)

CE 574 Laboratory Analyses in Water Quality Control - Experiments illustrating current chemical and biochemical methods of water and waste treatment and analytical methods used in research and control. (3 s.h.)

CE 575 Industrial Waste Treatment - Surveys and data analysis; use of unit processes to meet regulatory agency requirements; disposal of gaseous and solid residues. (2 s.h.)

CE 577 Treatment Plant Design - Design of works for the treatment of water and wastewater for municipalities and industries. (1-6 s.h.)

CE 579 Aquatic Microbiology - Ecology and physiology of microorganisms of inland waters, estuaries, and oceans; microbiology of wastewater treatment. (3 s.h.)

CE 580 Stream and Estuarine Analysis - Quantitative assessment of advection, reaction, and dispersion processes in polluted waters; reaeration theory; eutrophic systems; analog simulation. (3 s.h.)

FS 430 Air Pollutants from Combustion Sources - Generation of pollutants in combustion chambers; reduction by combustion control; pre- and post-combustion treatment of fuels and effluents.

HPA 420 Environmental Health - Identification, evaluation and control of environmental hazards. Biological and social considerations of the interaction of human populations with their physical environment. (3-6 s.h.)

ME 58 Acoustics and Noise Control - Sources, measurement, description of environmental noise, transmission loss, noise reduction at source by absorption, isolators and mufflers, noise measurement exercises. (3 s.h.)

ME 458 Noise Control in Machinery - Nature of noise sources in machine elements and systems. Propagation and reduction of noise. (3 s.h.)

METAL 460 Pollution Control in the Mineral Process Industries - Recycle, utilization and pollution control of air, water, and solid wastes from mineral processing plants. Pollution control through process modification. (3 s.h.)

METEO 310 Introduction to Atmosphere Science - Survey of atmospheric processes and analytical methods of atmospheric science. (3 s.h.)

METEO 452 Hydrodynamics of the Atmosphere - Equations of motion; circulation and vorticity; elements of turbulence theory and perturbation theory; introduction to numerical weather prediction. (3 s.h.)

METEO 453 Atmospheric Thermodynamics - Thermodynamic properties of the atmosphere with emphasis on water vapor; applications to forecasting problems. (3 s.h.)

METEO 475 Chemistry of the Atmosphere - Chemical properties of atmospheric components and contaminants. Dispersion and removal processes in connection with cloud physics, circulation, and air pollution. (3 s.h.)

MICRB 400 Introductory Environmental Microbiology - Elementary ecological relationships of microorganisms in the biosphere; role of bacteria in water pollution and purification. (2 s.h.)

MN EC 484 Political Economy of Energy and the Environment - Energy-its nature, use, markets and environmental impacts. (3 s.h.)

MNG 400 Mining and our Environment - For nonmining students. Nontechnical treatment of mining methods, practices, and role in today's civilization; socioeconomic and environmental problems. (3 s.h.)

NUC E 428 Radioactive Waste Control - Nature, sources, and control of radioactive wastes; theory and practice of disposal processes. (3 s.h.)

INSTITUTION: THE PENNSYLVANIA STATE UNIVERSITY

PROGRAM: Environmental Pollution Control

DEPARTMENT: Intercollege

DEGREE: Master of Science (M.S.); Master in Environmental Pollution Control (MEPC); Master of Engineering (ME)

CONTACT: Dr. John B. Nesbitt
Charge of Graduate Programs in Environmental Pollution Control
226 Merrell R. Fenske Laboratory
Pennsylvania State University
University Park, Pennsylvania 16802
(814) 865-1226

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

First initiated in 1971, the Environmental Pollution Control Program is an intercollege program dealing with various aspects of the control of air and water pollution and the disposal of solid wastes. Options are available in: Air Environment; Basic Physical and Biological Sciences; Environmental Health; Environmental Resource Management; Land Environment; Mathematics, Statistics, and Computer-Science; Noise; Planning; Pollutant Control in Industrial Processes; Radiological Protection; Systems Analysis; Water Resources - Quantity; and Water Resources Quality. An interdisciplinary faculty committee and participating departments provide graduate instruction. Other graduate faculty members other than those in the committee have a teaching and/or research interest in the area of environmental pollution control. Graduates are prepared to enter positions with consulting engineering firms, state, local, and federal regulatory agencies, and in private industry. Many have found positions with the Pennsylvania Department of Environmental Regulation and the Department of Transportation. Some have found employment with the U.S. Geologic Survey and EPA, for example. They have served in the capacities of operation plant inspectors, water or air pollution control specialists (not engineers), engineering assistants or technicians,and have prepared environmental impact assessments for consultants.

Research facilities utilized by the program's students are those maintained by the various participating departments at the University. There are none specifically designated for the Environmental Pollution Control Program. Research work conducted by students are sponsored by the various departments associated with the program.

PROGRAM REQUIREMENTS

Admission into the program is granted upon the recommendation of the head of the academic department in which the student plans to complete a program and the environmental pollution control program faculty committee. Mathematics through integral calculus, and one year of work in both general physics and chemistry is normally required for admission. Considered for admission are students with appropriate backgrounds in mathematics and science and a 2.75 junior-senior average.

Students enrolled in the Environmental Pollution Control Program are required to pass 9 credits of EPC core courses and 3 credits of EPC 590 seminars. One credit of the seminar in air is given during the fall term, one in water is given during the winter term, and one credit in solid waste management is offered during the spring. The core courses are: CE 472, Water Pollution Control Processes; CE 476, Solid Waste Management; and ME 470, Fundamentals of Air Pollution. Students not choosing to major in Water Pollution Control may substitute CE 473, Water Quality Management for CE 472, Water Pollution Control Processes.

In addition to the 12 credits of core courses and seminars,a minimum of 12 of the remaining 18 credits required for the master's degree must be selected from the EPC recommended courses list.

Master of Environmental Pollution Control: at least 9 of the student's total credits must be at the 500 level and these 9 credits should not include EPC seminars or credits taken to write the MEPC paper.

Master of Science in Environmental Pollution Control: at least 18 credits at the 500 and 600 level and these may include the EPC Seminars; and for most departments a thesis must be written.

Students can develop, with the help of an advisor in the selected department of affiliation, a program that will specialize in one area yet provide a basic comprehension of the problems encountered in other areas of environmental pollution control. The proposed program study, approved and signed by the student's advisor, is normally submitted to the program office within the first three weeks.

The student advisor, the head of the department of affiliation, and the EPC Program Chairman, determine the requirements concerning the research paper or thesis.

The university provides eight terms (2 years) of financial assistance to graduate assistants. Additional graduate assistance is provided through the student's departmental affiliation and usually involves work on funded research projects.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of forty faculty members contribute to the offering of the courses in the program. Thirty-three faculty are senior graduate faculty members and seven are associate graduate faculty members. They devote about 70 percent of their time to teaching activities and 30 percent to research.

There is a total of 26 full-time students enrolled in the Environmental Pollution Control Program. All except one student are male and there is only one part-time student in the program. About one-half of the students are affiliated with the Civil Engineering Department and the rest are from Agronomy, Veterinary Science, Mining Engineering, Geography, Meterology, Food Science, and Biological Health. Ten to fifteen students have graduated annually in recent years and the four-year average is 14 students. Enrollment and the number of graduates have remained relatively stable over the past couple of years.

The Environmental Pollution Control Program is designed to be a terminal Master's program. Resumes of students enrolled in the program and the Center for Air Environmental Studies are published and mailed to prospective employers. This has resulted in rather successful placement of graduates. About 95 percent of graduates find employment in their field and the rest are unknown. Approximately 30 percent find positions in governmental agencies, 40 to 50 percent in the private sector, and 20 percent in academia and other areas. Most finding positions with the Pennsylvania Department of Environmental Regulation serve as operations plant inspectors, conducting stream surveys, water or air pollution control specialists. Those finding positions with consulting firms are employed as engineering assistants or technicians, prepare 208 Areawide Planning Studies, prepare environmental impact assessments, and in sales. Some graduates take further fluid mechanics or waste treatment courses and thus obtain engineering work with consulting firms.

PROGRAM PROJECTIONS

Because of time and fiscal constraints, no change is expected to develop with the Environmental Pollution Control Program. The present orientation of the program is considered to be adequate in structure and no additional faculty members are expected to be recruited. There appears to be a leveling off of enrollment in the program to 25 to 30 per year.

COURSE DESCRIPTION

(the following is a partial listing of courses)

CE:

451 Advanced Hydrology - Recent advanced in deterministic, stochastic, and urban hydrology. (3 s.h.)

472 Water Pollution Control Processes - Principles and design of unit operations for water; domestic and industrial wastewater treatment; equipment selection and application. (3 s.h.)

474 Management of Water Pollution Control Processes - Personnel requirements, record systems, unit process operation and control, laboratory control and equipment maintenance systems. (3 s.h.)

476 Solid Waste Management - Solid waste collection, salvage and disposal techniques for municipalities and industries; cost analyses; legislation; management; financing; design optimization. (3 s.h.)

554 Urban Hydrology - Several hydrograph methods. Design storm and IUH application; airport drainage; flood plains; impact of urbanization upon groundwater and sediment. (3 s.h.)

570 & 571 Physical Chemical Treatment Processes I & II - The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. (2-3 s.h.)

573 Problems in Environmental Pollution Control - Investigations, analyses, and reports on current topics in environmental pollution control. (3 s.h.)

575 Industrial Waste Treatment - Surveys and data analysis; use of unit processes to meet regulatory agency requirements; disposal of gaseous and solid residues. (2 s.h.)

Mechanical Engineering

405 Air Pollution Control Systems - Small particles formation, properties, and behavior; equipment design and instrumentation; air pollution control, atomization, mass transfer, filtration. (3 s.h.)

458 Noise Control in Machinery - Nature of noise sources in machine elements and systems. Propagation and reduction of noise. (3 s.h.)

470 Fundamentals of Air Pollution - Nature, sources, transport, control, and effects of pollutants; sampling methods; air quality criteria and standards, economics, and planning. (3 s.h.)

Microbiology

400 Introductory Environmental Microbiology - Elementary ecological relationships of microorganisms in the biosphere; role of bacteria in water pollution and purification. (2 s.h.)

INSTITUTION: UNIVERSITY OF ALABAMA

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Engineering (Environmental Engineering)
Master of Science in Civil Engineering
Master of Science in Engineering Hydrology

CONTACT: Dr. George P. Whittle, Chairman
Environmental Engineering Committee
Department of Civil and Mineral Engineering
Box 1468
University, Alabama 35486
(205) 348-6550

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The formalized environmental engineering graduate program at the University of Alabama began in 1970 under a three-year training grant from the Environmental Protection Agency. The grant provided support for approximately four trainees per academic year; thirteen students received support during the grant period. The program was set up so that students from non-engineering as well as engineering disciplines could pursue graduate work in environmental engineering. This interdisciplinary program has been offered chiefly under the degree curriculums listed above.

The primary goal of the program is to provide training for those students in engineering and science who, in their graduate work toward a master's degree, wish to relate their specific fields to the areas of environmental pollution abatement and control. The training grant period served as a foundation for the currently offered degree programs. The program has grown stronger with regard to student population, faculty, courses and facilities.

Environmental engineering faculty have conducted short courses for utilities and governmental agencies, and participate in other related events such as coastal engineering conferences. They also have assisted with short courses offered annually to treatment plant operators, in cooperation with the Alabama Water and Pollution Control Association.

Environmental and energy-related research carry a high priority in the department, which receives research funds from a variety of governmental agencies, as well as private concerns. Between 1970 and 1977, a total of approximately one million dollars was received for research projects. Areas under study have included water treatment, stream analysis, water quality modeling, underground waste injection, coal mining pollution, and earth resource user identification, using data from orbiting satellites.

PROGRAM REQUIREMENTS

Students holding bachelor's degrees from engineering curriculums accredited by the Engineers' Council for Professional Development are eligible for acceptance into the program, as are students with degrees in the mathematical and physical sciences. The latter include, but are not limited to the disciplines of biology, chemistry, mathematics, physics, and geology.

To enter the M.S. in Civil Engineering program and major in environmental engineering, students must have forty-two credit hours of specified prerequisites. The required courses are in the fields of chemistry, mathematics (through differential equations), mechanical engineering (statics, particle dynamics, fluid mechanics and mechanics of materials) and civil engineering (sanitary engineering, wastewater disposal, and fluid mechanics). Students in this curriculum have a choice of two plans. Under Plan I, twelve hours of graduate courses in the major field, six hours in a minor field, six hours of electives, six hours of mathematics beyond differential equations, and a thesis are completed. Students selecting Plan II must complete eighteen hours in the major field, six hours in a minor field, nine hours of electives, and six hours of mathematics beyond differential equations.

Prerequisites for the M.S. in Engineering (Environmental Engineering) curriculum are similar to the above, except that courses in the mechanics of materials are not required. Students in this program also have two options, Plan I and Plan II, similar in structure and requirements to the above with the exception that the six hours of mathematics beyond differential equations are not required. In addition, at least six of the hours required in the major field must be numbered six hundred or above; they must include one course in air pollution and one course in water pollution. Two seminars are required.

The M.S. in Engineering Hydrology is open to all college graduates who have completed at least one semester's work each in chemistry and physics, mathematics through differential equations, and an engineering mechanics sequence through fluid mechanics. The program draws largely on courses offered by the Departments of Civil and Mineral Engineering, and Geology, with the collaboration of the Geological Survey of Alabama and the U.S. Geological Survey. The required course work is planned to meet the needs and interests of the student, and may be selected from many areas within the engineering hydrology program.

CURRENT FACULTY, STUDENTS, GRADUATES

Eight faculty members in the department participate, through teaching and research, in the environmental engineering program, although several other faculty members support the program to a lesser degree. There are sixteen students currently in environmental engineering. Six of these are seeking to obtain the M.S. in Civil Engineering, while the remainder are in the M.S. in Engineering (Environmental Engineering) program. A number of these students receive financial support from teaching assistantships, research grants or university-sponsored fellowships. Many, however, support themselves with part-time jobs.

During the years 1973 to 1976, two to three graduates were being produced per year. Presently, three to four complete an environmental engineering curriculum annually. Officials have followed up on graduates, and found that every graduate has been able to secure employment in the environmental field. Approximately 70 percent of these go to the private sector, the remainder to governmental agencies.

PROGRAM PROJECTIONS

Program sources believe that the enrollment will continue to grow in environmental engineering; within two years it is estimated that five persons will be graduating annually. Also forecasted is continued strength in teaching, research and service. These projections are based, in part, on documented past growth, and on efforts under way by faculty members. For example, discussions have been initiated with the Biology Department concerning elective course work available to both the biology and the environmental students in the respective departments. As a result, a new interdisciplinary M.S. degree in Biology (Aquatic Biology) may be developed. Faculty would also like to develop an interdisciplinary undergraduate program in environmental engineering. At present, however, it is very difficult to establish new degree programs within the university.

The rate of program growth and forecast fulfillment is dependent upon many factors, among which the financial support of graduate students is considered the most significant. Solicitations will continue for training grants, fellowships, and research projects.

COURSE DESCRIPTION

Partial listing of approved courses:*

CE 420 Sanitary Engineering Science - Atomic and molecular structure. Solution chemistry. Thermodynamics, reaction kinetics. Biological principles. Water supply development, water treatment and distribution. (3 s.h.)

CE 424 Wastewater Disposal - Biological and chemical principles of wastewater treatment systems and treated effluent disposal. Wastewater and storm flow collection systems. (2 s.h.)

CE 429 Environmental Science and Engineering - Principles of chemistry, physics, biology, and bacteriology applied to man's environment. Engineering, economic and social problems of air and water pollution resulting from man's activities. (3 s.h.)

CE 475 Hydrology - Factors governing the supply of ground water and the flow of streams and their relation to water power, water supply, drainage, and sanitary work. (3 s.h.)

CE 521 Industrial Hygiene - Environment in relation to health and work performance, emphasizing engineering control. (3 s.h.)

CE 522 Aquatic Biology for Engineers - Biology of natural streams and biological aspects of water quality. (3 s.h.)

CE 523 Water Treatment - The theory and practice of chemical and physical methods of water examination and treatment. (3 s.h.)

CE 525 Water Treatment Laboratory - Procedures used for the evaluation and control of water quality treatment processes. (1 s.h.)

CE 527 Water Supply Engineering - Water supply purification and distribution. General design of water supply systems and treatment plants. (3 s.h.)

CE 528 Wastewater Systems - Principles of sewage collection and treatment, design of sewerage systems and treatment plants. (3 s.h.)

CE 623 Water Treatment Processes - Recent developments in the chemical and physical treatment of water for municipal and industrial uses. (3 s.h.)

CE 624 Industrial Water Treatment - Quality requirements for specific industrial water supplies and design of pertinent treatment systems. (3 s.h.)

CE 625 Water Quality - Water quality criteria. Theory and practice of water analysis. (4 s.h.)

CE 626 Radiation Problems - Environmental radiation hazards. Sources and effects of radiation exposure. Evaluation and control of radiation hazards. (3 s.h.)

CE 628 Industrial Waste Treatment - Evaluation of industrial wastes relating the character and quality of wastes to design of treatment processes for satisfactory disposal of liquid wastes. (3 s.h.)

CE 621 Air Pollution Control - Sources and characteristics of air pollutants. Air quality management methods. (3 s.h.)

CHE 465 Atmospheric Pollution -Atmospheric pollution and control. Nature of pollutants including gases, dusts, vapors, and fumes; atmospheric dispersal; methods of analysis and administration; and standards and control of air pollution. (3 s.h.)

CHE 489 Air Pollution Control Systems Design - Applications of chemical engineering to collection of particulate matter and to removal of particulate matter and to removal of noxious gases. Cyclones, scrubbers, precipitators, absorbers, and reactors. (3 s.h.)

*Environmental courses in biology, marine science and chemistry are also approved, and courses in computer science and statistics may be incorporated into the curriculum. Course work in other areas may be approved upon petition of the committee.

INSTITUTION: UNIVERSITY OF ALASKA

PROGRAM: Environmental Quality Engineering

DEPARTMENT: School of Engineering

DEGREE: Master of Science (M.S.) in Environmental Quality Engineering

CONTACT: Dr. John L. Burdick
Acting Department Head
Environmental Quality Engineering and Science
University of Alaska
Fairbanks, Alaska 99801
(907) 479-7241

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Master of Science in environmental quality engineering was established at the University of Alaska in 1970. Course work emphasizes the biological, physical and chemical sciences as an academic base. In depth consideration is given to the environmental problems and solutions which relate to current and future developmental projects in arctic and subarctic climates.

Students may consider concentrations of study which include solid waste management, protection and treatment of water and wastewater and air quality control with emphasis on cold climates.

The University of Alaska is located in the subarctic of Interior Alaska. Due to this unique location, students and faculty have access to glaciers, permafrost areas and oceans. Situated in the nation's largest single wilderness area, the university is able to conduct controlled studies involving man's effects upon the environment. The University, therefore, has several research units, on and off campus, such as the Institute of Arctic Biology, the Arctic Environmental Information and Data Center, and the Institute of Water Resources. At the Institute of Water Resources, students and faculty, from the environmental quality engineering program, as well as from other programs and departments, are able to work on problems relating to the water resources of Alaska.

Although not affilitated with the University of Alaska, the Arctic Environmental Research Laboratory (AERL) is situated on the Fairbanks campus and is a part of the growing arctic research activities. The AERL is a multi-million-dollar U.S. Environmental Protection Agency research laboratory.

PROGRAM REQUIREMENTS

The requirements for the M.S. degree in environmental quality engineering include completion of 30 semester hours of credit composed of 18 credits of required courses, six credits of electives, and six credits of thesis study. Required courses include: EQE 601, 602, 603, 604, 605, and 606. Elective courses include EQE 692, 693, 694, and 697.

At present there is no internship program or applied study term associated with the environmental quality engineering program. There is limited financial assistance available to students.

CURRENT FACULTY, STUDENTS, GRADUATES

Current faculty includes two full-time teaching members. The student enrollment totals 12. Full-time students include two males and one female. Part-time students include eight males and one female. Usually, this program does not attract career-change students.

The number of per annum graduates has decreased over the last few years from six in 1975 to two in 1977. Graduates gain employment in the public and private sector about equally. Historically, graduates of this program choose a career path rather than continued educational pursuits.

PROGRAM PROJECTIONS

The faculty of environmental quality engineering look forward to moderate growth and expansion during the next few years. Although the student enrollment is forecast to increase somewhat, the faculty does not anticipate either increase or decrease over the next three years. Substantive changes in the program format are also not likely in the near future.

The construction of the Trans-Alaskan-Pipeline has served to increase public awareness of the necessity for maximum control and protection of Alaska's natural resources. Thus, actions involving the pipeline as well as the Alaska Native Land Claims Settlement may have an eventual impact upon the growth of the University of Alaska program.

COURSE DESCRIPTION

EQE 601 Environmental Quality Science Measurements - Theory and laboratory procedures for determining quality of water supplies. Natural water quality, pollution loads and water and wastewater treatment plant parameters. Familiarization with Standard Methods for the Examination of Water and Wastewater. Experiments on unit processes of treatment systems are included along with consideration for solid waste and air pollution monitoring. (3 s.h.)

EQE 602 Engineering Management of Water Quality - Concepts, rationale, theory, institutions and engineering aspects of water quality management. Methods of water quality management; low flow augmentation, in-stream aeration; stream and estaurine analysis; ocean disposal systems; diffuser analysis and design, control of thermal effluents, industrial discharges and arctic applications. (3 s.h.)

EQE 603 Solid Waste and Air Pollution - Planning, collecting and disposing of refuse. Techniques of open dumping, land filling, sanitary land filling, composting, incineration, and resource recovery. Solid Waste environmental relationships to water, air and land pollution. Economics and case studies are included. Air pollution topics will include quantity and quality of atmospheric emissions and their effects on man and his environment. Identification and location of sources, measurement of quality and standards. (3 s.h.)

EQE 604 Environmental Quality Evaluation - Topics of environmental impact statements; environmental law (local, state and federal); and environmental quality. Impact from projects of mining, highways, airports, pipelines, industrial development, water, wastewater and solid waste, and other-theoretical considerations and case studies.

EQE 605 Chemical and Physical Water and Wastewater Treatment - The theory and design of chemical and physical unit process utilizing the treatment of water and wastewater. Sedimentation and flotation, ion exchange, absorption, coagulation, precipitation, filtration, disinfection, reverse osmosis and aeration theories will be studied. Design problems for all unit processes. (3 s.h.)

EQE 606 Biological Treatment Processes - Study of the theoretical and applied aspects of wastewater treatment by biological processes including activated sludge, trickling filters, lagoons, sludge digestion and processing, septic tanks; analysis and design; nutrient removal processes, biology of polluted water, economics, state and federal regulations. (3 s.h.)

EQE 692 Seminar

EQE 693, 694 Special Topics - (0-3 s.h.)

EQE 697 Individual Study - (0-6 s.h.)

EQE 699 Thesis - (0-6 s.h.)

INSTITUTION: UNIVERSITY OF ARKANSAS (Fayetteville)

PROGRAM: Agricultural Engineering

DEPARTMENT: Agricultural Engineering

DEGREE: B.S. in Agricultural Engineering
M.S. in Agricultural Engineering
Ph.D. (coursework emphasizes Agricultural Engineering)

CONTACT: Dr. C. Roland Mote
Department of Agricultural Engineering
University of Arkansas
Fayetteville, Arkansas 72701
(501) 575-2351

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Agricultural Engineering is the application of engineering principles to the problems of agriculture; and the University of Arkansas offers undergraduate and graduate degree programs in this area at the Fayetteville campus. The program prepares students for a wide variety of positions in the design, development, and sale of agricultural machinery and equipment; for design and construction of soil and water control systems for public and private organizations; for design, advisory, and management positions with agricultural buildings and building-materials manufacturers and suppliers; for design and management positions with feed and food processing organizations; for engineering electricity in agriculture; and for teaching, research, and service with public and private agencies, institutions, and manufacturers.

Areas of concentration at the master's and Ph.D. levels and technical options during the junior and senior undergraduate years include crop and food processing, agricultural waste management engineering, soil and water engineering, agricultural power and machinery, agricultural structures, and electrical power in agriculture. The Agricultural Engineering Department also offers courses intended for degree programs for students majoring in other departments in the College of Agriculture and Home Economics (See Course Description).

The generalized nature of the Agricultural Engineering program permits continual modification of the students' training to meet changing occupational needs and interests. Research is considered an integral part of the program. Facilities include those of the College of Agriculture and Home Economics, the Engineering Experiment Station, and the university in general. Research funding currently totals $450,000 with $8,767 from the Environmental Protection Agency; $5,000 from the Office of Water Resource Technology; and the remaining allocation from formula funding under the Hatch Act.

PROGRAM REQUIREMENTS

The B.S. degree in Agricultural Engineering is granted after successful completion of the 132 semester hours prescribed in the curriculum. (This curriculum is under the joint supervision of the deans of the College of Engineering and College of Agriculture and Home Economics, but the degree is awarded by the College of Engineering.)

Candidates for the M.S. degree must complete a minimum of thirty semester hours. A minimum of twelve semester hours must be taken in the major department exclusive of a thesis, a minimum of eighteen hours must be taken in engineering, and the remaining hours may be taken in related fields. A thesis may be written or additional classwork may be substituted for the thesis subject to approval of the major professor and graduate school dean. General requirements for the Ph.D. are the completion of thirty semester hours beyond minimum requirements for a master's degree and the reading knowledge of a recommended foreign language or six semester hours in a related field consistent with the student's goals and program of study.

CURRENT FACULTY, STUDENTS, GRADUATES

There are eleven full-time faculty members in the Department of Agricultural Engineering with the equivalent of 3.0 lines for teaching and 8.0 lines for research. These staff members serve 57 undergraduate majors, three M.S. students, and two Ph.D. candidates (the first in the program). Approximately five B.S. and two M.S. diplomas are awarded annually, and the number at the undergraduate level should increase in the next few years. There have been, of course, no Ph.D. degrees conferred to date in this program. About 95 percent of the Agricultural Engineering graduates gain employment in their field with the remaining students taking engineering-related positions. The ratio of jobs taken in the private sector to the public sector is 50:50; graduates are typically employed as consultants, researchers, and extension specialists and in design, manufacturing, sales, etc. Sources of financial support include assistantships, scholarships, and work-study.

PROGRAM PROJECTIONS

The future for the Agricultural Engineering program at the University of Arkansas is bright, especially because of its close relationship with the production of food fiber. The continued growth of the department may necessitate the addition of another full-time faculty member with attendant laboratory and assistant support personnel. A new degree in food processing is in the discussion stage at Fayetteville, but no other major curriculum changes are expected.

COURSE DESCRIPTION *

Departmental courses for majors in Agricultural Engineering:

1012 Agricultural Engineering Design Fundamentals - Acquaints the student with the role and scope of the professional agricultural engineer. Basic engineering methodology including computation procedures is introduced and demonstrated by the application of fundamentals to specific agricultural engineering design and analysis problems. (2 s.h.)

3713 Engineering Properties of Agricultural Methods - The physical properties of farm products, agricultural chemicals and soils as utilized in the design of agricultural production and processing equipment, storage structures, and materials-handling systems. Methods of laboratory determination and an introduction to research techniques. (3 s.h.)

4404 Design of Structures for Agriculture - Environmental, functional, and structural requirements of buildings for agricultural production and science. Analysis and design of structural members and frames. Heat and moisture problems in agricultural biology and their control. (4 s.h.)

4905 Soil and Water Engineering - Engineering principles and methods of soil and water conservation, drainage, and irrigation. (5 s.h.)

5403 Agricultural Environmental Engineering I - Effects of environmental variables--temperature, air-velocity, radiant energy flux, humidity, light, air pollutants--on the growth, reproduction, and conversion efficiency of domestic animals and poultry. Physiological responses. Physical environment for storage of grains, seeds, and food materials. Environmental design; principles and methods of controlling environment, design for specific environmental factors--heating, cooling, control of radiation. Specialized problems in animal housing, food and feed storage, plant growth chambers, etc. (3 s.h.)

5413 Agricultural Engineering II - Energy-flow approach to studying the plant-soil-water atmosphere complex. Soil environment including moisture and heat flow. Plant responses to and effects on micro-environment. Energy exchange between the plant and the surrounding environment. Environmental requirements of plants. Engineering for a desirable plant micro-climate. (3 s.h.)

Departmental courses for non-majors:

2614 Fundamentals of Agricultural Engineering - Introduction to the major fields of engineering principles applied to agriculture: power and machinery, soil conservation, rural electrification, farm structures, and agricultural processing. (4 s.h.)

2973 Drainage and Erosion Control - Application of engineering principles to the solution of soil- and water-management problems with emphasis on land grading, field drains, open-ditch and grass waterway designs. (3 s.h.)

3013 Agricultural, Municipal, and Industrial Waste Management - The types, nature, and volumes of agricultural, municipal, and industrial wastes and the effect of these wastes on the environment. The control, management, and reuse of wastes to include final disposal. (3 s.h.)

3403 Structures and Environment for Agriculture - Physical environmental factors influencing production of animals and greenhouse plants. Methods of control. Space, light, temperature, moisture, gases: their relationships in the design of production buildings. Elements of building design. (3 s.h.)

4973 Irrigation - Methods of applying supplemental water to soils to supply moisture essential for plant growth; sources of water; measurement of irrigation water; pumps, conveyance structure, economics, and irrigation for special crops. (3 s.h.)

*Courses with left-hand digit 1 or 2 are normally open to freshman and sophomores, 3 or 4 to juniors and seniors, 5 to graduate students or to top-caliber seniors with special permission, and 6 to graduate students only.

INSTITUTION: UNIVERSITY OF ARKANSAS (FAYETTEVILLE)

PROGRAM: Environmental Science, Environmental Engineering, Civil Engineering

DEPARTMENT: Colleges of Agriculture and Home Economics, Arts and Sciences, and Engineering

DEGREE: Bachelor of Science in Environmental Science [interdisciplinary] (B.S.); Master of Science in Environmental Engineering (M.S.En.E.); Master of Science in Civil Engineering with Environmental Option (M.S.)

CONTACT:
Dr. Hugh M. Jeffus, Coordinator
Environmental Science Program
College of Engineering
University of Arkansas
340 Engineering Building
Fayetteville, Arkansas 72701
(501) 575-4955

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The University of Arkansas at Fayetteville has declared its environmental training programs to be an "area of excellence" within the institution. At least three major degrees fall under this environmental studies rubric at Arkansas--the B.S. in Environmental Science implemented in 1972, the M.S. in Environmental Engineering also implemented in 1972, and the M.S. in Civil Engineering with an Environmental Option. All seek to give the student a practical, non-theoretical training in preparation for work in industry and the private sector.

The objectives of the interdisciplinary B.S. degree in Environmental Science are four-fold: 1) to expose students at the undergraduate level to many different facets of environmental studies (e.g., waste management, air and water pollution, economics of environmental management, pesticide management); 2) to help students better understand people and the institutions which bring about change in our society in order to facilitate work with problem solvers and to inform citizens about issues concerning them; 3) to prepare students for in-depth environmental studies at the graduate level; and 4) to enable them to work as problem solvers with problem solvers (e.g., engineers, sanitation experts, landscape designers, and others interested in protecting and improving the environment). In addition to basic courses in biological, social, and physical sciences, mathematics, and communications, students must take a number of environmental science courses designed especially for this major. Degrees are awarded either in the College of Agriculture and Home Economics or in the College of Arts and Sciences, whichever the student chooses.

The M.S. in Environmental Engineering was originally developed because students in chemical, electrical, mechanical, and agricultural engineering wanted an industrial background upon completion of their coursework. Rather than award them the M.S. in Civil Engineering, which would not accurately represent their training, the M.S.En.E. was instituted. The curriculum offers a wide spectrum of environmentally-related courses.

The M.S. in Civil Engineering with Environmental Option closely parallels the M.S.En.E. in terms of coursework. However, the former degree offers a more intensive engineering plan of study and requires credits beyond those for the Environmental Engineering degree.

The University of Arkansas (Fayetteville) operates the basic facilities necessary to train its students currently, but faculty note that funding is needed to maintain equipment and to provide needed additional space. The faculty in the Department of Civil Engineering who are involved in the environmental training programs are actively involved in research. Current projects include defining the needs of a community for water and wastewater treatment facilities; investigating the feasibility of transporting coal from Montana and Wyoming to Arkansas via a vast water pipeline and the energy and water-pollution considerations of such an endeavor; conducting studies of air pollution from paper mill waste treatment facilities, volatile chemical emissions from wastewater lagoons, and the impact of individual household disposal systems and septic tank tile fields; and reviewing the technology available to water systems in rural areas.

The research funding currently in effect totals $102,600. Sponsoring agencies include the Environmental Protection Agency, Arkansas Office of Public Safety, Office of Water Research and Technology, Arkansas Department of Soil and Water Resources, Southwestern Electric Power Company, National Science Foundation, and the university.

PROGRAM REQUIREMENTS

The B.S. in Environmental Science requires the completion of 132 semester hours including a core of Environmental Science courses (crosslisted in the Departments of Agricultural Engineering, Agronomy, Entomology, and Civil Engineering). The M.S. in Environmental Engineering requires a B.S. degree in engineering or a B.S. degree with courses in calculus, statics, dynamics, mechanics of materials, hydraulics, hydrology, civil engineering fundamentals, and thermodynamics or electric circuits and machines. (These courses should require approximately one calendar year to complete in addition to the graduate courses.) The M.S. in Civil Engineering with Environmental Option requires a B.S.C.E. Generally, Master of Science degree candidates must complete a minimum of 30 semester hours. A minimum of 12 semester hours must be taken in the major department exclusive of a thesis and a minimum of 18 hours must be taken in engineering.

CURRENT FACULTY, STUDENTS, GRADUATES

Five full-time faculty members divide their time evenly between teaching and research in the environmental program within the Department of Civil Engineering. All are paid by the university; but if research projects become unmanageable, non-tenured research associates are occasionally added to the staff for the duration of the project and paid by that grant money.

There are approximately 25 full-time undergraduate Environmental Science majors (1/3 are women), one M.S.C.E. with Environmental Option candidate (three more just graduated), and five full-time and 30 part-time (FTE=20) M.S.En.E. students. The first graduates are just now completing the B.S. in Environmental Science program, but their annual numbers should average about 15 graduates per year. The enrollment in the M.S.En.E. program is relatively stable (eight graduates per year) and is composed in great measure by students at the Graduate Institute of Technology, a unit of the Fayetteville campus in Little Rock.

The enrollment statistics reflect in part the job market in engineering and the lack of graduate student support available. There are graduate research slots open at the master's degree level, but the starting salaries and pay increments offered B.S. graduates entice potential graduate students away from the university (with its comparatively meager salaries) and into industry. Also, the faculty can supervise only a limited number of graduate students and still teach and conduct the research projects that employ those students. The ratio of jobs to students is approximately 5:1 at the B.S. level and 2.5:1 at the M.S. level. Placement is roughly one-third in industry, one-third in consulting, and one-third in government (regulatory agencies, pollution control departments, etc.); but recently faculty have noted a shift by graduates from industry and government to the private consulting firms. Students are recruited to the graduate environmental programs from the undergraduate student body and from other "hard sciences" where the job market is considerably less open.

PROGRAM PROJECTIONS

Given the current high level of involvement by the faculty in teaching and research, plans to move into the energy area in terms of curriculum have been postponed. No additional staff members are expected to be added in the next five years. Faculty predict a steady, though not dramatic, growth in environmental programs, but note that regulations from the Environmental Protection Agency can drastically affect the type of training necessary for tomorrow's graduates. There are no plans to develop a program at the doctoral level at this time; rather, Arkansas wants to maintain and upgrade its current "area of excellence" in the environmental sciences.

COURSE DESCRIPTION

Environmental Science core courses:

ENSC 1003 Environmental Science - Series of lectures and discussions introducing the topic of environmental sciences including factors related to water, soil, and air quality. Taught jointly by agricultural, arts and sciences, and engineering faculties. (3 s.h.)

ENSC 1203 Soils and Man's Environment - Soils as a natural resource in relation to man's environment. Chemical, physical, and biological properties of soils are studied from the viewpoint of being a resource that can be both a pollutant and polluted. (Same as Agronomy 1203) (3 s.h.)

ENSC 2003 Environmental Management - Man's interaction with the air, water, and land environment in which he lives. The role of engineering as well as other disciplines in the control of pollution for the health and welfare of mankind. (Same as Civil Engineering 2003) (3 s.h.)

ENSC 3013 Waste Management - Types, nature, and volumes of agricultural, municipal, and industrial wastes and the effect of these wastes on the environment. Control, management, and reuse of wastes to include final disposal. (Same as Agricultural Engineering 3013 or Civil Engineering 3013) (3 s.h.)

ENSC 4043 Pesticides Ecology - Development and classifications of pesticides, programs of use and environmental interactions. (Same as Entomology 4043) (3 s.h.)

ENSC 4413 Economics of Environmental Management - An economic approach to problems of evaluating private and social benefits and costs of altering the environment. Emphasis given to the interaction of individuals, institutions, and technology in problems of establishing and maintaining an acceptable level of environmental quality. (Same as Agricultural Economics 4413) (3 s.h.)

Recommended courses in Environmental Science:

BOT 4504 Principles of Plant Ecology - Plants in their environments, emphasizing field methods and vegetation communities of Northwest Arkansas. (4 s.h.)

ZOOL 4814 Limnology - Physical, chemical, and biological conditions of inland waters. (4 s.h.)

CE 5743 Aquatic Biology for Engineers - Fundamentals of aquatic biology and biological systems applied to environmental

CE 5743 (Cont'd) - engineering. Familiarizes the student with limnological concepts and methods, field sampling techniques, and laboratory methods commonly associated with stream pollution and water quality problems. (3 s.h.)

BACT 4613 Public Health and Sanitation - Public health aspects of disease spread, environmental pollution, and food contamination, with emphasis on sanitary practices applicable in control. (3 s.h.)

CE 4263 Public Health Engineering - Investigation of engineering practices in the public health field pertaining to epidemiology, biostatistics, and disease transmission, including the concepts of sanitation practices in supplying milk, food, and water. Sanitary engineering applications to disease areas, major pollution sources, and industrial hygiene are included. (3 s.h.)

CE 5753 Air Pollution - Terminology, theory, and laboratory aspects of air pollution. Emphasis placed on the interpretation of laboratory data for effective engineering control technology. (Same as Ch.E. 5753) (3 s.h.)

Environmental Engineering courses:

CE 3203 Environmental Engineering - Introduction to fundamentals. Course emphasis is upon water supply and wastewater treatment. (3 s.h.)

CE 4223 Surface Water Hydrology - Detailed investigations of hydrologic runoff relationships of surface and groundwater flow. Study of hydrograph and routing techniques as well as evaporation and sedimentation of storage reservoirs. Application of hydrologic techniques to engineering design. (3 s.h.)

CE 4243 Water and Wastewater Process Design - Application of physical, biological, and chemical operations and processes to the functional design of water supply and transmission as well as water and wastewater treatment plants. (3 s.h.)

CE 4253 Water Resource Planning and Economics - Investigation of water-resource projects from the broad engineering viewpoint of the impact on society of design, justification, financing, construction, and operation. Emphasis is placed on engineering economy studies of public works projects, and the political aspects of decisions by public works agencies. (3 s.h.)

CE 4263 Public Health Engineering - (see above)

CE 4273 Water Resources Planning and Design - Planning, design, and economics of water supply and wastewater disposal units. Topics include the analysis and design by modern optimization techniques to minimize construction and operational costs in meeting required water quality standards. (3 s.h.)

CE 4283 Solid Waste Management - Refuse collection and disposal with emphasis on system analysis in organizing and operating collection systems, methods of volume reduction and disposal and an economic evaluation of solid waste disposal problems. (3 s.h.)

CE 5234 Water and Wastewater Analysis - Basic concepts of each of the eight fields of chemistry are reviewed in light of their application to sanitary engineering. Quantitative determinations of constituents in water and wastewater are presented. Introduction to principles of bacteriological laboratory techniques. (4 s.h.)

CE 5253 Sanitary Microbiology - Fundamental and applied aspects of microbiology and biochemistry relating to water-quality control, wastewater treatment, and stream pollution. (3 s.h.)

CE 5273 Industrial Water Supply and Wastes Treatment - Industrial water requirements. Limitations of water quality and quantity. Stream pollution investigation. Study of industrial processes and how they affect water supply, sewage treatment, and stream recovery. Treatment and disposal of industrial wastes. (3 s.h.)

CE 5293 Water Treatment & Distribution System Design - Design of industrial and municipal water treatment plants. Discussion of raw and treated water requirements for the several areas. Distribution system analysis and design including distribution storage and pumping. (3 s.h.)

CE 5723 Radiological Health Engineering - Basic concepts of radiation. Radiation sources, physical and biological effects, protective measures. Engineering uses of radiation and radioactive isotopes. (3 s.h.)

CE 5734 Advanced Wastewater Process Design and Analysis - Application of advanced techniques for the analysis and design of wastewater treatment facilities. Physical, chemical, and biological processes for removing suspended solids, organic solids and nitrogen and phosphorous will be investigated. Laboratory treatability studies will be used to develop design relationships. (4 s.h.)

INSTITUTION: UNIVERSITY OF CINCINNATI

PROGRAM: Air Pollution, Industrial Hygiene

DEPARTMENT: Environmental Health

DEGREE: Master of Science in Air Pollution or Industrial Hygiene
Doctor of Philosophy in Air Pollution or Industrial Hygiene

CONTACT: Dr. Bernard E. Saltzman
Environmental Hygiene Program
Department of Environmental Health
Room 107, Kettering Lab
University of Cincinnati
Cincinnati, Ohio 45267

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

According to a recent publication by the Department of Environmental Health at the University of Cincinnati, its "scientific and educational interests . . . are largely a response to the need to understand the nature of environmental hazards, to probe their biologic and ecologic impact, particularly their effects on human health, and to develop methods of prevention and control." As part of that response, graduate study sequences in Industrial Hygiene and Air Pollution were developed in 1954 and 1960 respectively. The Industrial Hygiene program is the second or third oldest in the U.S., and the university holds the nation's oldest grant for Air Pollution training. The Air Pollution program is conducted jointly with the Department of Civil and Environmental Engineering in the College of Engineering. The bulk of students following the Industrial Hygiene program are employed in the private sector, while those students trained in Air Pollution usually find jobs in control agencies.

The Department of Environmental Health and the Industrial Hygiene program within it are heavily engaged in research and outreach programs. The faculty offer one-to-two week courses for professionals in industrial hygiene and one- to three-day courses on occupational health hazards for employers and employees of small businesses in an area within 150 miles of Cincinnati. The Department also offers a weekly seminar open to the university community and the public to which "distinguished leaders in their specific fields are invited to present new scientific information and new approaches to critical problems."

Facilities include laboratories in air flow measurement and calibration, dust sampling and evaluation, instrument calibration, air sampling, noise measurement and control, industrial hygiene chemistry, and respiratory protection. The nearly research units of the National Institute for Occupational Safety and Health (NIOSH) and the Environmental Protection Agency (EPA) provide excellent facilities to students and staff; both federal units maintain a close relationship with the Department. NIOSH has recently designated the University of Cincinnati as one of nine Educational Resource Centers in the country in industrial hygiene and safety, industrial health nursing, and occupational medicine; the center is charged with developing an outreach program and providing materials to regional schools in these industrial areas.

In addition to the $500,000 annual NIOSH grant (five years), the program has received funding from EPA, the Energy Research and Development Administration (now the Department of Energy), and the Occupational Safety and Health Administration. Grant monies are critical to the program because they are the major source of faculty salaries and graduate student stipends.

PROGRAM REQUIREMENTS

Students entering the programs in Industrial Hygiene and Air Pollution must have a baccalaureate degree and have majored in chemistry, biology, engineering, or related fields. Formal requirements for the M.S. degree are the satisfactory completion of at least 45 quarter credit hours of graduate courses, including research, and the preparation of a thesis. The Ph.D. degree requires completion of 135 graduate credits, 45 of which must be earned in residence at the University of Cincinnati, and an acceptable dissertation. All students complete a core program of lecture courses, seminars, and research in the Environmental Health Department and also a group of electives preparing each of them for a chosen area of specialization in professional practice or teaching. The time required for completing the M.S. degree varies from one to two years. For a majority of students with a B.S. degree, four years of graduate work are necessary to complete the requirements for the Ph.D. degree

CURRENT FACULTY, STUDENTS, GRADUATES

Ten full-time faculty members, who devote an appropriate fraction of their time to teaching and the remainder to research, serve students in these programs. As of Autumn 1977, enrollment figures were as follows:

AIR POLLUTION

M.S.		Ph.D.	
Full-time	4	Full-time	2
Part-time	4	Part-time	6

INDUSTRIAL HYGIENE

M.S.		Ph.D.	
Full-time	23	Full-time	8
Part-time	22	Part-time	0

The differences in enrollment between these two areas is in part due to the financial support available to graduate students. Graduate student support currently comes from a variety of sources: EPA loan fund, NIOSH stipends, ERDA stipends in Industrial Hygiene, research work on department grants and contracts, summer employment with EPA and NIOSH, armed forces service, and foreign governments. The shrinking support from EPA for Air Pollution training has reduced the number of students sustained in this area of concentration, while growing support from NIOSH and OSHA continues to draw increasing numbers of students into the Industrial Hygiene program.

For both programs combined, there are approximately 16 M.S. and 2-3 Ph.D. degrees awarded annually. Upon completion of the M.S. degree, approximately 10 percent continue work on a Ph.D. and many do so at the University of Cincinnati. Of the 105 graduates over the last 8 years, 60 percent have taken jobs in the private sector and 40 percent have entered government work. There are numerous job opportunities due to the legislation requiring industry to provide safe working conditions.

PROGRAM PROJECTIONS

The declining financial support in Air Pollution makes the future of that program tenuous; the faculty can be sustained through other funding sources, but the graduate students cannot. There has been some discussion related to expansion of the program into the water pollution area. The NIOSH Educational Resource Center grant will help to build the Department's Industrial Hygiene program and develop a graduate program in Industrial Safety.

COURSE DESCRIPTION

Environmental Health: 701, 702, 703 Environmental Health Seminar - Lectures and discussions covering a broad range of problems in environmental health led by guest lecturers in their field. (1 q.h. each qtr.)

707, 708, 709 Environmental Hygiene Technology I - Lectures, demonstrations on problems arising from man's environment. Industrial hygiene, air pollution fundamentals and practices. (3 q.h. each qtr.)

725, 726, 727 Teaching Practicum in Environmental Health - Practice of assisting and teaching in environmental courses by special arrangement with faculty member who will provide supervision. (2 q.h. each qtr.)

741, 742 Air Sampling and Analysis I and II - Calibration of sampling equipment, collection, analysis of pollutant gases, vapors, particulate matter. (3 q.h. Aut., Win. qtr.)

747, 748 Environmental Sanitation - Basic principles, practices of water and public health engineering. Municipal refuse collection, disposal; food, milk sanitation; pest control; housing, recreational sanitation. (2 q.h. each qtr.)

751, 752 Occupational Dermatology - Applied physiology and anatomy of skin. Etiology, evaluation, treatment, and prevention of environmental dermatoses. (2 q.h. Aut., Win. qtr.)

771 Biological Effects of Air Pollutants - Investigation and identification of the health effects of air pollutants on human beings, other animals, and plants. (2 q.h. Spr. qtr.)

772 Energy and Environment - Environmental impact studies of energy generation and utilization including fossil-fuel, nuclear power, waste recycling. (3 q.h. Win. qtr.)

775 Industrial Hygiene Laboratory - Evaluation of chemical, physical hazards in industrial workplaces. Potential hazards include noise, glare, heat, dust, solvents, electromagnetic radiation. (3 q.h. Spr. qtr.)

779 Industrial Ventilation - Principles of air flow through ventilation systems and their design for industrial uses starting with simple foods and progressing through complex systems. (2 q.h. Win. qtr.)

780 Air Pollution Meteorology - Theory, application of meteorology applied to air pollution, including diffusion computations, tracer studies, urban diffusion experiments, air quality cycles, pollution incidents. (4 q.h. Win. qtr.)

781 Introduction to Occupational Health - Principles, philosophies, basic concepts of medical engineering, and other disciplines in research and practice of occupational health. (1 q.h. Aut. qtr.)

782 Toxicology - Introduction - Entry, action and elimination of toxic chemicals; dose-response relationships; experimental toxicology, design, interpretation and application of the data. (3 q.h. Win. qtr.)

785 Introductory Physiology - Basic biological principles with lectures, demonstrations on structure function in mammals. (3 q.h. Aut. qtr.)

790 Physical Aspects of the Environment - Principles and techniques of recognizing and evaluating problems of non-ionizing radiation, ultarviolet, visible, infrared, and microwave. (1 q.h. Spr. qtr.)

791 Master's Thesis Research - Credits to be arranged.

792 Principles of Ergonomics - Concepts, criteria to achieve optimal mutual fitting of capabilities of the worker. Biomechanics, (heat, cold, vibration, noise, chemicals) fatigue, vigilance, behavioral factors. (2 q.h. Spr. qtr.)

796 Introduction to Statistics - Descriptive statistics, probability, estimation, statistical errors, parametic and non-parametric hypothesis testing, statistical fallacies. Emphasizes applied-practical aspects. (4 q.h. Spr. qtr.)

834, 835, 836 Environmental Quality Management- Seminar encompassing social, technical, economic, and institutional issues of water, solid wastes, noise, and community development programs. (2 q.h. each qtr.)

873 Basic Industrial Safety - Content, administration and implementation of safety programs in industry. Covers good practices and governmental regulations. (2 q.h. Aut. qtr.)

875 Basic Health Physics - Evaluation of exposures to ionizing radiation. Air sampling, personal protection and monitoring of industrial exposures. (2 q.h. Win. qtr.)

877 Theory and Applications of Aerosol Technology - Applications of industrial aerosol technology: sampling, characterization, statistical methodology. (2 q.h. Spr. qtr.)

901, 902, 903 Instrumental Methods of Analysis of Pollutants I, II, III - Lecture lab. Autumn: Chromatography; Winter: Air monitoring instrumentation; Spring: Spectroscopy. (3 q.h. each qtr.)

904, 905, 906 Environmental Hygiene Technology II - Field trips to representative industrial plants to illustrate principles of industrial operations and methods employed in controlling physical, chemical hazards. (3 q.h. each qtr.)

973 Design of Environmental Quality Monitoring Programs - Objectives, types of standards and monitoring programs, statistical aspects of monitoring and of anlytical quality control. (2 q.h. Spr. qtr.)

991 Doctoral Disseration Research - Credits to be arranged.

771-5; 871-5;971-5 Special Topics-Air Pollution - Seminars, or tutorial sessions dealing with special topics in air pollution related to research and application basic to field of environmental health. (cr. arr.)

781-5; 881-5; 981-5 Special Topics - Industrial Hygiene - Seminars or tutorial sessions dealing with special topics in industrial hygiene as related to research and application basic to field of environmental health. (cr. arr.)

INSTITUTION: UNIVERSITY OF CINCINNATI

PROGRAM: Civil and Environmental Engineering (Environmental Engineering and Sciences)
DEPARTMENT: Civil and Environmental Engineering
DEGREE: Master of Science
Doctor of Philosophy

CONTACT: Dr. Louis M. Laushey, Head
Department of Civil and Environmental Engineering
College of Engineering
University of Cincinnati
Cincinnati, Ohio 45221
(513) 475-3648

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Engineering and Sciences program at the University of Cincinnati permits master's and doctoral degree candidates to specialize in a number of areas including air and water pollution control, solid wastes control, and water and waste chemistry and microbiology. Current program objectives are "to provide a broadly based interdisciplinary program of coursework, research, and practical training which enables graduates to function in a wide range of environmental quality management and engineering operations." To achieve this blend of research and practical application, many students alternate terms of coursework with cooperative work programs in related industries and government agencies."

The program enjoys the benefits of several nearby research units--those of the U.S. Environmental Protection Agency and the National Institute of Occupational Safety and Health. Other facilities available in the community include the Herman Schneider Laboratory of Basic and Applied Science Research, the Laboratory of Basic and Applied Nuclear Research, the Kettering Laboratory and Institute of Environmental Health, Children's Hospital Research Foundation, the Robert A. Taft Sanitary Engineering Center, the Ohio River Valley Sanitation Commission, and the Ohio River Division of the Corps of Engineers. The departmental laboratories are equipped "to perform research in the quality of air and water and research in solid waste characterization and management."

Research funding from the Environmental Protection Agency (loan program in air, training grant in water) and other agencies and consulting work by individual faculty members provide financial remuneration and practical experience to students. Current EPA-financed projects include a training film on methodology for technicians and studies on "Graduate Training in Water Pollution Control" and "Effect of Particulates on Disinfection of Enteroviruses in Water by Chlorine Dioxide."

Weekly seminars on environmental topics co-sponsored by the Department and the EPA and open to the public provide an ideal setting for "significant interaction" among students, faculty, professionals, and community members. Presentations in the Autumn 1977 series included "Control Priorities for Toxic Pollutants in Water," "Charging the Polluter," and "Beyond Detection? Carcinogens and Toxicants in Our Water."

PROGRAM REQUIREMENTS

For admission to the Environmental Engineering program, applicants should have a bachelor's degree in engineering or science, a record of high scholarship, and the ability for advanced study and research. Graduates of related noncivil engineering curricula may be required to takepreparatory courses.

The minimum requirements for a M.S. degree are 36 graduate quarter credits of coursework and 9 credits of thesis research or 45 total credits. If a non-thesis option is granted by the student's committee, a minimum of 51 graduate quarter hours is required, 45 of which should be formal courses (not thesis, research, readings). With either option, a minimum of 12 graduate credits of mathematics plus science are required.

For the Ph.D. degree, 135 graduate credits past an acceptable B.S. degree, or 90 credits past an acceptable M.S. degree are required. Of these, 45 credits must be under the direction of the Civil and Environmental Engineering faculty. Hours of coursework vary from 45 to 60 depending on how many hours are allotted to the dissertation (30-45 range).

CURRENT FACULTY, STUDENTS, GRADUATES

Seven full-time faculty in Environmental Engineering and Sciences and two staff members from related areas as well as six adjunct faculty (from EPA, etc.) serve approximately twenty-two full-time and fifty-five part-time graduate students in this program. Most students receive some financial support (air loans, water training grants, assistantships, part-time jobs).

The average number of graduates annually (20-25) is growing steadily. Statistics for recent years reveal 48 percent of the graduates have entered government work; 16 percent, consulting; 16 percent, industry; and 20 percent, teaching, other employment, or unknown. Extensive follow-up records are maintained in the Department. Only a few master's students (10 percent) pursue doctoral degrees--an indication that the M.S. degree program currently prepares one well for future careers.

PROGRAM PROJECTIONS

Though the program currently operates several well-equipped laboratories, its recent self-evaluation report notes, "Reductions in outside funding through the training grant mechanism coupled with significant reductions in University contributions has resulted in a leveling off in laboratory operations over the past five years. It does not appear that this trend can be reversed unless governmental funding of environmental programs is increased substantially." That same report indicates that "the instructional program is expected to remain essentially in its present form" and "more emphasis . . . placed on Systems Analysis and Mathematical Modelling." Faculty assessments are that the current program strengths lie in water and air training, but that financial and laboratory support are needed to promote a reputable solid waste curriculum.

COURSE DESCRIPTION*

Civil and Environmental Engineering:

614 Solid Waste Disposal - Introduction to the problem of solid wastes and the methods used for their disposal. (2 q.h.)

618, 619 Environmental Microbiology I - Basic principles of biology, and biochemistry with emphasis on the activities of microorganisms and their effect on man and his environment. (2 q.h. each qtr.)

620 Environmental Microbiology II - Microbiology of air, solid wastes, soil wastes, soil, water and wastewater. (2 q.h.)

625 Water Pollution Control - Application of engineering and scientific principles in waste treatment. (3 q.h.)

635 Air Engineering and Control of Gaseous Air Pollutants - Fundamental gas laws, air engineering (hoods, ducts & blowers), control of gaseous pollutants (absorption, adsorption and incineration). (3 q.h.)

636 Air Engineering - Fundamental gas laws, psychometrics; heating and coding; design of hoods and ducts; fan laws and fan selection. (2 q.h.)

637 Control of Gases Pollutants - Includes process control as well as effluent control by absorption, adsorption and incineration. (2 q.h.)

640 Fundamentals of Small Particle Behavior - Physics of particles: size and size distribution, mechanics of motion, agglomeration, diffusion, electrical effects and light scattering. Applications to sampling deposition, visibility. (3 q.h.)

641, 642, 643 Environmental Engineering Seminar - Lecture and discussions of topics relating to the control of the environment. Guest lecturers as well as student presentations. (1 q.h. each qtr.)

644 Fundamentals of Small Particle Behavior - Physics of particles; size and size distribution, mechanics of motion, agglomeration, diffusion, electrical effects and light scattering. (2 q.h.)

645 Environmental Sanitation - A survey of public health practices as related to environmental control. Insect and rodent control, food and milk sanitation, refuse disposal, housing. (2 q.h.)

646 Environmental Microbiology I - Basic principles of biology, microbiology, and biochemistry with emphasis on the activities of microorganisms and their effect on man and his environment. (4 q.h.)

647 Environmental Chemistry I - Analytical methods in environmental chemistry. Purposes, procedures and principles of the analysis of water and liquid wastes. (4 q.h.)

649 Environmental Microbiology II - Microbiology of air, solid wastes, soil, water and wastewater. (3 q.h.)

650 Environmental Microbiology III - Examination of microbiological techniques and applications useful in applied microbiology. To be taken concurrently with Environmental Microbiology II. (1 q.h.)

651 Water Pollution Control - Application of scientific and engineering principles to receiving water quality control. (3 q.h.)

652 Environmental Chemistry II - Current water chemistry theories and their application to the treatment of water, wastewater, and industrial waters. (3 q.h.)

653 Design of Environmental Control Systems - Unit process, unit operation concept applied to design of systems used for environmental control. (5 q.h.)

661 Air Pollution Control - A general course. Air quality management, effects and control engineering, administrative and legal aspects of control programs. (3 q.h.)

662 The Air Pollution System - An overview of air pollution control: major pollutants, their characteristics, effects and standards; natural and man-made sources, sinks; meterological transport; air pollution literature and its use. (3 q.h.)

663 Automotive Air Pollution and Control - Causes of air pollution in internal combustion engines. Methods of reducing pollution, test methods, legal and political aspects of control. (3 q.h.)

664 Air Pollution Law, Regulations and Management - Technical aspects of air pollution control programs and organization and management

664 (Con't) - of control programs in government and industry. Air pollution laws and regulations in the U.S. and abroad. (4 q.h.)

665 Air Pollution and Combustion Chemistry - Chemical and physical fundamentals of combustion processes and formation of primary gaseous pollutants. Introduction to photochemical smog and formation of secondary pollutants. (3 q.h.)

667 Effects of Air Pollutants - Review and analysis of the data on the effects of air pollutants on humans, animals, plants and materials and their relationship to ambient standards. (2 q.h.)

709 CE Lab - Instrumental methods of water and air analysis, using gas chromatography, atomic, adsorption, UV-visible and infrared spectrophotometry. (3 q.h.)

718 Solid Waste Analysis - Analytical methods in environmental chemistry. Purposes, procedures, and principles of the analysis of solid wastes. (3 q.h.)

754, 755, 756 Design of Environmental Control Systems - Unit process, unit operation concept applied to design of systems used for environmental control. (2 q.h.)

741 Air Pollution Engineering Laboratory - Particle measurements, source and collector performance testing. (3 q.h.)

742 Photochemical Air Pollution - Photochemical air pollution, atmospheric reactions; air pollution effects in atmosphere. (3 q.h.)

690 Watershed Hydraulics - Energy, momentum, flow rates and profiles. Groundwater, wells. Sedimentation, erosion, transport. River regulation, equilibrium and regime; long-term effects of man's works. (3 q.h.)

691 Environmental Hydraulics - Interdisciplinary hydraulics of fluid and solid transport in environmental engineering. Piping systems and networks. Optimization. Water hammer. Corrosion control. (3 q.h.)

692 Hydraulic Design of Plants - Hydraulic design for wastewater treatment and pumping facilities. Hydraulic models, pilot plants. Control structures. Pumps, power conversion. (3 q.h.)

693 Hydraulic Engineering I - Open channel flow: nonuniform and unsteady. Reservoir and river flood routing. Flow through culverts. Sanitary engineering hydraulics. (3 q.h.)

694 Hydraulic Engineering II - Waves. Erosion. Pipe networks. Water hammer. Ground water flow, wells, and flow nets. Sedimentation.

694 (Cont'd) - Model studies. (3 q.h.)

695 Groundwater Hydrology - Groundwater hydraulics. Water well design. Basin development. Underground disposal, pollution. (2 q.h.)

697 Environmental Hydrology - Interdisciplinary hydrology. Hydrology balances. Statistical methods. Rainfall-runoff process. Urban watershed models. Control methods. (3 q.h.)

698 Water Resources Control - Basic concepts of open channel flow. Channel transitions and controls. Control structures. Storage routing. (2 q.h.)

699 Hydrology - Interdisciplinary study of ponds, lakes, and rivers. Hydrographic methods of analysis. Limnology. Eutrophication. Renovative processes. (2 q.h.)

* Courses listed are taught by Departmental faculty, but courses acquired from other departments are utilized extensively, especially from the Department of Environmental Health, Department of Chemical and Nuclear Engineering, and Department of Mathematics.

INSTITUTION: UNIVERSITY OF CINCINNATI

PROGRAM: Environmental Health

DEPARTMENT: Environmental Health

DEGREE: Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Gary Cooper
Environmental Health Division
Department of Environmental Health
Room 36, Kettering Lab
University of Cincinnati
Cincinnati, Ohio 45267
(513) 872-5725

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Institute of Environmental Health at the University of Cincinnati offers coursework leading to M.S. and Ph.D. degrees with specialization in environmental health (environmental biology, biochemistry, physiology and pathophysiology). Training and research efforts are designed "to enhance our understanding of man's ecosystem so that detrimental effects can be prevented and controlled." Master's degree candidates formulate plans of study that introduce them "to the sources, methods of evaluation, and entry and effects of important hazardous materials to the general population." Doctoral candidates bring a specialization in a basic scientific area (e.g., biochemistry, microbiology, chemistry, zoology, physiology, pharmacology, engineering) to bear on fundamental research questions and problem-solving strategies in environmental health. The division is oriented to the doctoral level and the training of specialized environmental scientists.

Research funds essentially constitute faculty salaries in this program and come from a variety of sources: National Institute of Health, National Institute of Occupational Safety and Health, U.S. Army, American Petroleum Institute, and the Environmental Protection Agency. Projects include studies of behavioral aspects of auto-exhaust sulfates, ecological characteristics of estuaries, water reuse systems, and coal pollutants. Examples of current areas of research exploration are:

(1) The role of trace metals in human health and disease as affected by environmental factors;
(2) Pulmonary problems of environmental origin; and
(3) Development of environmental quality study techniques and analytical methods.

Facilities available to students and staff are extensive and located both on campus and in the environs of Cincinnati. Among these are laboratories in environmental hygiene technology, environmental medicine, epidemiology, biostatistics, toxicology, physiology, neurophysiology and behavior, and basic biological sciences. Facilities for animal and human subject investigations are also available. The U.S. Environmental Protection Agency and the National Institute of Occupational Safety and Health operate research units nearby and maintain cooperative programs with the Department of Environmental Health.

PROGRAM REQUIREMENTS

Students must have or develop a basic science background for entrance into the Environmental Health program. All candidates complete a core program of lecture courses, seminars, and research and a set of professional electives preparing them for specialized career work. The time required for completing the master's degree ranges from one to two years; entry with a B.S. degree usually results in a four-year doctoral program.

Doctoral candidates are expected to understand biological mechanisms of response and are urged to take a course in biochemistry. If one's basic science background is a physical science, he/she should have a course in physiology. In addition to required basic science and enviromental health courses, all students must elect at least nine hours of additional coursework in environmental health although most elect more. Candidates will also be required to take a new course called Introduction to Environmental Health beginning in the fall of 1978. Elective hours enable the student to integrate his/her basic science background with environmental health problems. Students holding an M.S. degree begin research in their first year, while B.S. degreed students begin research upon completion of basic science courses.

CURRENT FACULTY, STUDENTS, GRADUATES

Eleven full-time faculty members with three-quarters time devoted to research and one-quarter time given to teaching and administrative duties serve the Environmental Health Division students (3 M.S., 13 Ph.D.). The number of graduates at the master's level has been declining, while the number at the doctoral level is increasing. Stipends, tuition fellowships, and research assistantships are available. Approximately one quarter of the program's graduates have entered industrial jobs with the remaining students entering government work (especially M.S. students) or university teaching and research (especially Ph.D.).

PROGRAM PROJECTIONS

Recent faculty additions have strengthened the curriculum in psychology and biochemical carcinogenesis. The program hopes to hire a staff member with specialization in respiratory physiology and needs someone with training in pulmonary physiology to develop the air pollution emphasis of the curriculum. Requirements and faculty appointments reflect an increasing degree of structure in the environmental health field.

With current legal regulations for toxicological and enviromental testing and monitoring, increased numbers of environmental health scientists will be needed in the next decade, according to division faculty. If government funding remains constant and economic factors do not interfere, the Environmental Health program at the University of Cincinnati should enjoy a stable, healthy future.

COURSE DESCRIPTION*

Environmental Health:

701, 702, 703 Environmental Health Seminar - Lectures and discussions covering a broad range of problems in environmental health led by guest lecturers considered leaders in their field. (1 q.h. each qtr.)

782 Toxicology I - Entry, action and elimination of toxic chemicals; dose-response relationships; experimental toxicology, design, interpretation and application of the data. (3 q.h.)

785 Introductory Physiology - Basic biological principles with lectures, demonstrations on structure, function in mammals. (3 q.h.)

787 Introduction to Biostatistics - Descriptive statistics, probability distributions, estimation sampling, types of error, significance level, test of hypotheses, sample size, correlation, linear regression. Emphasizes practical-applied aspects. (4 q.h.)

880 Toxicology II - Principles of absorption, distribution and excretion of foreign compounds. (4 q.h.)

*Courses represent fundamental requirements for students and are by no means all-inclusive. Students also take a biochemistry course and a mammalian physiology course as part of their preparation for research work.

INSTITUTION: UNIVERSITY OF CINCINNATI

PROGRAM: Occupational Medicine

DEPARTMENT: Environmental Health

DEGREE: Master of Science in Environmental Health (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Edward A. Emmett, M.D.
Department of Environmental Health
Division of Clinical Studies
University of Cincinnati Medical Center
231 Bethesda Avenue
Cincinnati, Ohio 45267
(513) 872-5284

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

According to a program brochure from the University of Cincinnati's graduate program in Occupational and Environmental Medicine:

> Occupational and environmental medicine is a clinical and research field of medicine of considerable social and professional importance. It is a medical speciality concerned with the diagnosis, prevention and treatment of diseases and injuries resulting from exposure to chemical agents, products or processes at work or within the environment. It is an attractive speciality for the physician interested in solving problems for which the hazardous environmental components can be probed and identified. It is a branch of medicine in which preventative measures will result clearly in the control or elimination of the health problems.

The Occupational Medicine program within the Department of Environmental Health offers graduate study leading to the M.S. and Ph.D. degrees. The program's two-year residency satisfies "the training requirements of physicians for certification in Occupational Medicine by the American Board of Preventative Medicine." Both residency and degree requirements are flexible enough to meet changing student interests and career objectives such as "(1) the delivery of medical care in an industrial setting or health maintenance organization, (2) research and teaching in an academic unit or national agency, or (3) health affairs administration at a corporate or governmental level."

The program benefits from a close proximity to numerous centers and facilities. Among these are a large Medical Center complex (Colleges of Medicine, Nursing and Health, and Pharmacy); three hospitals; the

College of Engineering; research units of the National Institute of Occupational Safety and Health and the U.S. Environmental Protection Agency; and a "large industrial complex with resources such as industrial medical and safety programs as well as potential hazards, which are materials for training."

A recent grant proposal enumerates the equipment and instrumentation housed in the Departmental laboratories: atomic absorption spectrometers; infrared, visible, and ultraviolet spectrophotometers; gas chromatographs; amino acid analyzer; X-ray diffraction equipment; electron microscopes; ultra centrifuges; scintillation counters; electrophoresis apparatus; air pollution monitoring instruments; noise evaluation equipment; a variety of sampling devices; dust counting equipment and ancillary apparatus; inhalation exposure chambers; cold rooms; experimental and clinical pulmonary function laboratories; a controlled temperature and humidity chamber; cell culture facility; audiometric room; trace metal facility for housing and feeding small animals under rigid environmental and nutritional control; and a clinical pathology section. Library and computer facilities are up-to-date and extensive.

Current grant monies from NIOSH, the National Institute of Environmental Health Sciences, and other government agencies (not EPA) and industrial contracts support the Occupational Medicine program and its faculty. Short-courses for physicians and EPA and NIOSH personnel and a mini-residency providing a one-month, intensive training session for physicians supplement the regular curriculum offerings.

PROGRAM REQUIREMENTS

Requirements for acceptance into the residency include graduation from an approved medical school and completion of at least one year of internship (or residency) in a relevant field from a program which is approved by the Council on Medical Educational Hospitals on the American Medical Association. Foreign students have additional requirements.

The curriculum is "formal" though "flexible" and "strives to blend practical clinical occupational medicine and patient care." The core curriculum in environmental and industrial hygiene, toxicology, epidemiology, and biostatistics "encompasses environmental hazards and principles of their control, clinical practice of occupational medicine and the planning, administration and evaluation of health problems." Electives provide concentration in areas such as "air pollution research and control, radiobiology and radiation health, applied psychiatry, environmental sanitation, experimental design, public health administration and other relevant subjects." Clinical activities, industrial hazard evaluations, and work with federal and local regulatory and research units enhance the training opportunities. A required residency in industry usually occupies one's third year in the program unless it has been completed prior to entry into graduate work.

CURRENT FACULTY, STUDENTS, GRADUATES

Four full-time and twenty part-time faculty serve eleven full-time and one part-time graduate students in the Occupational Medicine program. With little fluctuation, five degrees (mostly M.S.) are conferred annually on the average. There have been approximately 120 graduates from the program since its inception in 1952.

Stipends from NIOSH, the U.S. Navy, and foreign governments support currently enrolled students. Jobs are plentiful for those students completing the program. Graduates are employed in government (37%), industry, often as corporate medical directors in charge of environmental concerns (38%), consulting (under 5%), and academia (20%).

PROGRAM PROJECTIONS

No major curriculum shifts are anticipated in the Occupational Medicine program which currently is seen as flexible enough to allow diverse specialization in the field. There are no program limitations due to equipment and facilities though outside funding must continue. However, the enrollment does demand additional staff--a need which can be met if qualified people are found to fill the two currently open faculty lines and one line opening next fall. Graduates from this program should find an open job market for some time.

COURSE DESCRIPTION

Environmental Health:

701, 702, 703 Environmental Health Seminar - Lectures and discussions covering a broad range of problems in environmental health led by guest lecturers considered leaders in their field. (1 q.h. each qtr.)

704, 705, 706 Applied Psychiatry for Occupational Physicians - Seminar discussions, conferences, and interviews to provide understanding of the application of psychiatric methods to common occupational medical problems. (1 q.h. each qtr.)

707, 708, 709 Environmental Hygiene Technology I - Lectures, demonstrations on problems arising from man's environment. Industrial hygiene, air pollution fundamentals and practices. (3 q.h. each qtr.)

719, 720, 721 Topics in Clinical Toxicology II - Exposure, clinical effects, pathology, prevention and treatment of industrial toxicants for physicians. (1 q.h. each qtr.)

722, 723, 724 Occupational Medicine - Clinical practice of occupational medicine for physicians. (2 q.h. each qtr.)

731, 732, 733 Basic Science in Relation to the Skin - Three-quarter course which discusses anatomy, physiology, biochemistry of skin related to skin diseases, cutaneous toxicology. (1 q.h. each qtr.)

751, 752 Occupational Dermatology - Applied physiology and anatomy of skin. Etiology, evaluation, treatment, and prevention of environmental dermatoses. (2 q.h. each qtr.)

776 Introduction to Epidemiology - Methodology used in studies of disease in human populations. Examples of chronic disease and infectious disease epidemiology. Sources, collection, handling, interpretation of health data. (3 q.h.)

781 Introduction to Occupational Health - Principles, philosophies, basic concepts of medical engineering, and other disciplines in research and practice of occupational health. (1 q.h.)

787 Introduction to Biostatistics - Descriptive statistics, probability distributions, estimation sampling, types of error, significance level, test of hypotheses, sample size, correlation, linear regression. Emphasizes practical-applied aspects. (4 q.h.)

810, 811, 812 Environmental Health Medical Clinics - Diagnostic evaluation, clinical management of environmental health problems at appropriate clinics; includes services in general medicine, chest diseases, dermatology. (3 q.h. each qtr.)

816, 817, 818 Clinical Toxicology and Pharmacology - Bedside rounds and seminars illustrating practice of clinical toxicology as applied to drug overdoses and poisonings by nontherapeutic agents. (2 q.h. each qtr.)

831, 832, 833 Chemical and Biological Effects of the Human Environment - Pharmacological agents, agricultural chemicals, and trace metals. (2 q.h. each qtr.)

873 Basic Industrial Safety - Content, administration, and implementation of safety programs in industry. Covers good practices and governmental regulations. (2 q.h.)

880 Toxicology II - Principles of absorption, distribution and excretion of foreign compounds. (4 q.h.)

904, 905, 906 Environmental Hygiene Technology II - Field trips to representative industrial plants to illustrate principles of industrial operations and methods employed in controlling physical, chemical hazards. (3 q.h. each qtr.)

910 Industrial Toxicology Practice - Medical, toxicological evaluation of industrial materials, consumer products. (2 q.h. each qtr.)

INSTITUTION: THE UNIVERSITY OF DELAWARE

PROGRAM: Environmental Engineering

DEPARTMENT: Multidisciplinary (sponsored by College of Engineering)

DEGREE: Master of Applied Science
Master of Engineering in one of the departmental areas
Doctor of Philosophy in Applied Science
Doctor of Philosophy in Chemical Engineering
(or Applied Science)

CONTACT:
Dr. Lloyd A. Spielman
Committee Chairman of Environmental Engineering Program
Rm. 356, Dupont Engineering Building
University of Delaware
Newark, Delaware 19711
(302) 738-2431

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The College of Engineering in 1970 established an interdepartmental program in environmental engineering involving the departments of engineering, chemistry, and biology. This multidisciplinary program is available at the master's and Ph.D. level to all graduate students in engineering and students whose undergraduate majors were in chemistry, physics, or the biological sciences. Major subject areas include air and water pollution control, agricultural effects of pollutants, and environmental resources. The purpose of the program is to enable students with varied engineering and scientific backgrounds to increase markedly their ability to apply the tools and training of engineering to solve environmental problems. Students are first admitted to one of the engineering departments.

The degree requirements for this program are determined by the engineering departments to which the student is admitted. The environmental engineering program is coordinated by an Environmental Engineering Committee comprised of members from each of the departments of the College. Members of the Committee are available to assist students in developing a program of study oriented toward the student's area of special interest in environmental engineering.

The Civil Engineering Department has facilities for research in the environmental engineering disciplines with a supporting machine shop for constructing specialized research equipment. The environmental engineering laboratories contain equipment for conducting physical and chemical tests, as well as standard apparatus for chemical and biological analyses of water, wastewater, and air. The department also has access to late model analog and digital computing facilities for both instruction and research. Research in the chemical engineering laboratories includes air and water pollution control (particularly as related to abatement by catalytic means).

PROGRAM REQUIREMENTS

Applicants wishing to enter the program must first fulfill the requirements of the engineering department with which they want to be affiliated. Program officials state that undergraduates must have taken courses in environmental biology, general geology, chemistry and introductory environmental engineering if they enter the graduate program as University of Delaware undergraduates.

Candidates for the master's degree may pursue either the Master of Applied Science degree or a master's degree in one of the departmental areas. At the Ph.D. level, students in civil engineering and mechanical engineering work toward a Ph.D. in Applied Science and those in chemical engineering pursue the Ph.D. in Chemical Engineering or Applied Science.

The degrees of Master of Chemical Engineering (M.Ch.E.), Master of Civil Engineering (M.C.E.), Master of Electrical Engineering (M.E.E.), and Master of Mechanical and Aeorspace Engineering (M.M.A.E.) are conferred under the direction of those departments. General requirements for the master's degree in the College of Engineering include completion of 24 semester hours of approved course credit or equivalent, plus 6 hours thesis with an average grade of B (residence and foreign language not required). Six hours of thesis or 6 hours of research, or a combination of both are allowed. The minimum amount of credits without thesis is 30 semester hours. Students usually in the non-thesis program are required to pass a comprehensive examination. A maximum of 9 credit hours transferred from continuing education or from another institution may be applied to the degree hours required. For the Master of Civil Engineering, the student may elect, after consultation with a faculty advisor, to replace the thesis with nine credit hours of additional course work and a comprehensive examination.

For the Master of Applied Sciences degree, the requirements of the College of Graduate Studies must be satisfied. These require 30 credits, of which 6 shall be a thesis. In addition, 12 hours of course credit obtained in 800-level courses are normal requirements for the degree.

General requirements for the Doctor of Philosophy degree include at least three academic years of work subsequent to the baccalaureate degree. At least one continuous academic year must be devoted exclusively to full-time study in the major field at the University. Students are also expected to pass comprehensive and final examinations and prepare a thesis. Theses may be written in absentia in chemical, civil, and mechanical and aerospace engineering.

For the Ph.D. degree in Applied Sciences, both oral and written examinations are given by the student's individual graduate committee after completion of the foreign language requirements which are at the discretion of the student's advisory committee. Instead of majors or minors, the applied sciences program requires proficiency in the area of interest and the area of mathematics, physical and engineering science.

Full-time graduate students are eligible to apply for fellowships, traineeships, assistantships and loans. University fellowships are awarded to graduate students on an all-University basis and are unrestricted as to the student's field of graduate study. Each provides a stipend of $2,800 for the academic year and tuition is remitted. Industry, foundations, and private individuals have donated funds to support a number of fellowships for University graduate students. Teaching assistants receive stipends ranging from $2,800 to $3,300 for the academic year and tuition is remitted. Eighty percent of the full-time students receive some form of financial assistance which mostly consists of research assistantships and fellowships. Sixty percent of the full-time students receive research assistantships or fellowships; twenty percent receive teaching assistantships; and twenty percent support themselves.

CURRENT FACULTY, STUDENTS, GRADUATES

Four full-time faculty members contribute to the teaching of the program's curriculum. Two post-doctorates are involved in full-time research. Most of their research funding is for wastewater research.

Current enrollment (Fall, 1977) in the master's program is 14 full-time and 15 part-time students. Only one of the full-time students and four of the part-time students are female. Most of the graduate students spend two years in residence to complete the requirements for the degree. The enrollment in the M.S. program has remained constant over the last few years. Total enrollment in the program is currently 30 (including one Ph.D. candidate).

It is estimated that 6 M.S. students and 1 Ph.D. annually receive degrees on the average. It is estimated that 70 percent of the graduates find private sector jobs (40% consulting, 30% industry). Some find positions in chemical engineering, mobile environmental engineering, and research; consulting jobs have been found in organic recycling of wastes. Also, a few students have obtained positions at Dupont which is located nearby. One part-time student holds a position as head of environmental engineering at Aberdeen Proving Ground. A smaller percentage of graduates (30%) hold academic or governmental positions. Some of the part-time students are administrators of local environmental agencies and take additional coursework. Also, some of the part-time students are degree bound. An advantage to part-time students is the fact that all of the graduate course offerings in the program are offered at 4:30 P.M. or later.

PROGRAM PROJECTIONS

It is not anticipated that the program will significantly increase in enrollment or structure in the next few years. Because of the multi-disciplinary nature of the program, additional faculty members can be recruited to teach courses in other areas of interest.

COURSE DESCRIPTION (SELECTED)

GEO 601 Environmental and Applied Geology - The application of geologic principles to matters of environmental concern. (2 s.h.)

CE 331 Introduction to Environmental Engineering - An introductory course in which the student is exposed to interactions within the environment and to the associated engineering problems. Discussions of air and water supply, wastewater treatment, solid wastes, industrial wastes, and their effect on the environment. (3 s.h.)

CE 431 Design of Environmental Control Facilities - Concepts of chemistry, biology, and engineering applied to design of systems for collection, transportation, and treatment of water and wastewater; introduction to water and air quality of criteria; stream pollution. (3 s.h.)

CE 443 Water Resources Engineering - Study of the development, use and allocation of water for irrigation, navigation, flood control, hydropower, water supply, conservation and recreation. (3 s.h.)

Graduate courses:

CE 630 Environmental Health Engineering - Broad application of engineering principles to environmental problems. (3 s.h.)

CE 633 Physical Aspects of Environmental Engineering - Physics of particulate matter in air and water. (3 s.h.)

CE 635 Air Resources Engineering - Air pollution - its causes, effects on environment; and control. (3 s.h.)

CE 637 Water Quality and Pollution - Water quality standards and criteria for various beneficial uses of water. (3 s.h.)

CE 831 Theory of Water Treatment - Application of chemical, biological, and engineering techniques to water treatment processes; aeration, sedimentation, filtration, disinfection, control of taste and odors, etc. (3 s.h.)

CE 832 Theory of Wastewater Treatment - Composition of wastes. Treatment and disposal of sludges produced at wastewater treatment plants. (3 s.h.)

INSTITUTION: UNIVERSITY OF GEORGIA

PROGRAM: Environmental Health Science

DEPARTMENT: Dairy Science

DEGREE: Bachelor of Science in Environmental Health (B.S.E.H.)

CONTACT: Dr. Harold Barnhart, Chairman
Program in Environmental Health Science
University of Georgia
Athens, Georgia 30602
(404) 542-2454

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This multidisciplinary program was organized in 1970. Students receive training which prepares them to be examined for state certification as sanitarians. Environmental health scientists are in demand by governmental agencies, private industries and institutions. Opportunities for employment exist in various specialized programs within public health agencies in such areas as food and milk technology, solid waste management, vector control, general sanitation engineering and pollution control. Environmental scientists are employed in programs of water and air pollution control, quality control, industrial hygiene and a variety of other activities by a significant number of agencies and commercial concerns. This program is non-accredited.

The program makes use of the faculty and special facilities of many departments, particularly those of Entomology, Microbiology, Dairy Science, Poultry Science, Agricultural Engineering, and Food Science. During the first two years, students follow the general core curriculum for the Bachelor of Science for Agriculture. Within the Georgia university system, students may not declare a major until they have completed their sophomore year and they must declare one prior to their junior year. Each specified Environmental Health Science course is accompanied with a detailed course outline for the students.

PROGRAM REQUIREMENTS

Those people wishing to enter the freshman class should have taken college preparatory high school subjects, which include English, mathematics (at least one year of algebra), science, history, and a foreign language. Students who have had a foreign language for two years are required to take the College Board Achievement Test in that language. The College Entrance Examination Board's

Scholastic Aptitude Test and Mathematics Achievement Test are required of all freshman applicants.

The general core curriculum which freshman and sophomores in the College of Agriculture are required to take is composed of twenty quarter hours of course work in the humanities; ten of these are in English, twenty hours in the mathematics and natural science area, twenty hours in social science, and thirty-five hours of courses which are related to the major. Related courses include ten hours of biology, botany or zoology; five hours of statistics; five hours of physics; five hours of graphics; five hours of chemistry; and five hours of physical education.

At the beginning of their junior year, Environmental Health Science students begin work on the major requirements and electives. Seventy quarter hours of designated coursework in the six departments which are involved are required. Students are given a list of thirty-seven suggested courses which are environmentally related for fulfillment of the thirty hours of electives required; however, students are not restricted to these listed courses.

Cooperative education opportunities exist with the Environmental Protection Agency Air and Water Surveillance Laboratory in Athens, Georgia. Students recieve pay for their work. Additional financial support is available on a competitive basis in the form of six departmental scholarships. Other coop opportunities may be developed as need arises.

CURRENT FACULTY, STUDENTS, GRADUATES

One full-time person coordinates and teaches the five courses which are specified environmental health. Faculty from six distinct departments teach twenty major courses out of which students select twelve. Certain of these faculty provide additional support in an advisory capacity to the coordinator.

There are seventy-five students enrolled full-time, 88 percent of whom are Georgia residents. Twenty-five to twenty-seven people graduate year on the average. It is felt that this program will have reached its ceiling when the enrollment increases by fifteen students. Many times due to space limitations laboratories which were designed to accomodate twelve students must serve as many as twenty-five students at a time; space is a critical problem.

Even though efforts were made to follow-up on graduates of the program, information is limited due to poor response to the questionnaire which was sent. An official estimates, however, that 20 percent of the graduates seek advanced degrees, 30 percent work in governmental positions, and 50 percent are employed in the private sector.

PROGRAM PROJECTIONS

No real changes are foreseen for this program. There is no faculty growth anticipated and no increase in the space allotted, two aspects where need has been identified. The maximum growth in enrollment which can be permitted is by fifteen students.

COURSE DESCRIPTION

Sample of major courses:

ENT 477 Chemistry and Toxicology of Insecticides and Fungicides - A study of the biology, use and impact of insecticides and pesticides in agriculture and their chemistry in the environment. (5 q.h.)

EHS 459 Microbiology of Water and Wastewater - In-depth study of microbial life of water and wastewater, domestic and industrial, with scrutiny of current treatment processes. Sampling methods will be demonstrated along with proper storage of samples. Study made on the effects of different types of waste on microbial population of rivers and streams. (5 q.h.)

MIB 350 Introductory Microbiology - A survey of microorganisms with special emphasis on bacteria and their relationship to man. (5 q.h.)

ENT 374 Agricultural Entomology - Introduction to entomology. Recognition and control of insect pests of crops and animals. Designed for non-entomology majors. (5 q.h.)

ENT 376 Medical Entomology - Introduction to entomology. Species of insects and related arthropods of particular importance in cause or transmission of disease. (5 q.h.)

FS 407 Microbiology of Foods - Microorganisms in natural and processed foods; their origin, nature, and effects on foods; enumeration; relationship to health. (5 q.h.)

FS 421 Environmental Microbiology - Role of environment on organisms; agents to retard, inhibit, or stimulate bacteria and their mode of action; dynamics of physical, physiological and chemical agents; isolation of anaerobes and factors affecting sporogenesis, dormancy, spore germination and differentiation. (5 q.h.)

DS 411 Microbiology for Sanitarians - Study of microorganisms in fluid milk and milk products, their relation to spoilage and epidemiology. Inspection and enforcement procedures. (5 q.h.)

DS 350 Dairy Chemistry - A basic study of the chemical and physical properties of milk; analysis of milk and milk products according to standard methods. Functions and operation of a dairy control laboratory. (5 q.h.)

AGY 464 Soil for Multipurpose Use - Soil as an important part of our natural resources with emphasis on genetic properties which influence the soil's use for non-farm purposes. Principles involved in developing and managing soils for a quality environment. (5 q.h.)

Samples of suggested electives:

AEN 448 Instrumentation for Environmental Quality - Basic principles of operation of instrumentation used to measure physical variables which determine environmental quality. (5 q.h.)

ECN 402 Economics of Natural and Environmental Resources - Analysis of economic and physical prinicples underlying use of natural resource base. Economic sources of environmental problems. 5 q.h.)

BIO 350 Ecology - Biotic populations and communities. Population structure and dynamics, organization and classification of communities, nutrient and energy flows in ecosystems, and principles of systems ecology. (5 q.h.)

GLY 302 Mineral Resources and the Environment - Historical influence of mineral resources. National and international policy. Mining and petroleum industry. Depletion allowances. Conservation vs. mining. Sufficiency of mineral resources. (5 q.h.)

INSTITUTION: UNIVERSITY OF KANSAS

PROGRAM: Environmental Health Engineering; Environmental Health Science

DEPARTMENT: Department of Civil Engineering

DEGREE: Master of Science in Environmental Health Engineering
Master of Science in Environmental Health Science
Doctor of Philosophy in Environmental Health Engineering
Doctor of Philosophy in Environmental Health Science

CONTACT: Dr. Ross E. McKinney
Environmental Health Program
4002 Learned Hall
University of Kansas
Lawrence, Kansas 66043
(913) 864-3731

PROGRAM DESCRIPTION:*

PROGRAM STRUCTURE

The graduate programs in Environmental Health Science and Engineering at the University of Kansas emphasize that our environmental pollution problems demand a variety of approaches and ideally a training appreciation for both science and engineering. From its inception at the M.S. level in 1961 and the Ph.D. level in 1965, the Environmental Health curriculum has encouraged close faculty-student interaction on research projects of mutual interest. The faculty have chosen to develop a "quality" program producing a select group of graduates rather than a "quantity" program producing many.

Primary areas of research are the technical and social aspects of air and water pollution control, water quality, and solid waste management. Currently, the program receives training grants in water from the Environmental Protection Agency (EPA), EPA research support in wastewater treatment, industrial support, and municipal contracts that permit on-the-job training for students. A close working relationship with the EPA regional office in Kansas City is maintained, and students have used EPA facilities in conjunction with thesis work. Research funding presently totals $70,000.

The Environmental Health programs are currently housed in the C. L. Burt Laboratory which has the instrumentation necessary to perform all of the analytical measurements usually associated with research investigations in water quality. Air quality instrumentation is being developed. A roof deck to accommodate outdoor experiments is available as are the following major pieces of equipment: infrared, visible, ultraviolet, atomic absorption, and gas-liquid spectrophotometers; carbon, hydrogen, nitrogen, and oxygen analyzers for solid materials; Warburg and continuous-flow automatically recording respirometers; four constant temperature rooms; automatic titrimeter;

torsion balances; remote location automatic water sample collector; polarographic and galvanic remote location dissolved oxygen analyzers; Meloy labs SO_2 monitor and hydrocarbon analyzer; mast ozone and nitrous oxides meters; Beckman infrared carbon monoxide monitor; and Hi-Vol particle sampler.

Completely equipped microbiology and hydraulics laboratories and computer and library facilities are also available. Study and research space are utilized in Moore Hall, the new home of the Kansas State Geological Survey. The regional office of the Water Resources Division of the U.S. Geological Survey is located on campus and provides a readily available source of basic hydrologic and chemical water quality data. The Environmental Health and Water Resources programs, both located in Learned Hall, are closely coordinated.

The department conducts three two-day workshops on special topics for people in industry and this year sponsored its 28th Sanitary Conference (regional) for consulting engineers, state agencies, EPA personnel, and municipal employees. The workshops and conferences are designed to address specific, regional concerns.

The current emphasis of these University of Kansas programs is perhaps best described by Professor Ross E. McKinney:

> Currently, the Environmental Health programs start with foundations on chemistry and biology and build through the fundamental principles of the physical, chemical and biological processes that are used to develop solutions to problems in air pollution, solid wastes, wastewater pollution and water treatment. In addition, the students are encouraged to examine the administrative relationships, the legislation affecting the different areas of environmental pollution control and systems analysis related to both large and small scale problems. Research still forms a major part of the educational experience of many students; but it has been recognized that some students have greater needs for additional course material and lesser needs for the research experience at the M.S. level... Many International students come from areas of the world where the need for improved environments is urgent and the need for new solutions from research has a low priority. These International students need to maximize their technical information base by taking more courses. A Special Problem study on an important technical area of concern to their own country replaces the thesis for International students electing the non-thesis option.

PROGRAM REQUIREMENTS

Admission to the Environmental Health Engineering programs ordinarily requires a B.S. in Civil Engineering, while qualified students who do not have the C.E. degree but who have a baccalaureate degree with major emphasis in physical or biological science may be admitted to work toward a degree in Environmental Health Science. All candidates for the M.S. degree have two options available to them: Option A which requires 30 semester hours including a thesis of 10 hours and a final oral examination defending the thesis, or Option B which requires 33 semester hours including a 3-hour special problem investigation in the area of special interest to the student and a written final examination. The two Environmental Health master's degrees require courses in chemistry, biology, and environmental process concepts.

The Ph.D. Environmental Health degrees require 72 semester hours at the graduate level including those earned for the M.S. degree. A student must spend the equivalent of three full academic years in resident study at the University of Kansas or some other approved institution including the time spent earning the master's degree. Each candidate must complete two basic skills which contribute most to his/her research effort, in addition to those acquired as part of the approved plan of study. Possible basic skills are foreign language, computer skills, mathematical skills, laboratory techniques, or physical and biological science skills.

CURRENT FACULTY, STUDENTS, GRADUATES

There are presently four full-time and one part-time faculty members in the Environmental Health programs. Their time is split between teaching and research, a fact that reflects the departmental philosophy emphasizing close faculty-student interaction in training activities. There are 18 M.S. and 7 Ph.D.s in Environmental Health Engineering and 12 M.S. and 3 Ph.D.s in Environmental Health Science. Approximately 20 students are pursuing degrees on a part-time basis; and a majority of these individuals are engineers employed in either the Kansas City metropolitan area or in Topeka. The Environmental Health program has offered courses through the School of Engineering's evening program for engineers in the Kansas City area who wish to pursue graduate coursework. The high demands on the faculty brought about by student enrollments in both Lawrence and Kansas City have led to Saturday morning or early a.m. courses during the week so that part-time students and regular students can take the classes together. Evening courses have been offered by dual communication television in both cities. According to Dr. McKinney, "the combination of regular students with the part-time students active in practice has produced the added benefit of making the course material more relevant to real world problems that are being faced while the course is being taught."

The program, which has no trouble recruiting students, attracts people from the biological and chemical sciences who want to learn how to solve problems using their undergraduate knowledge. Financial support for students is available through the EPA training grants; research and teaching assistantships; and, of course, through part-time work in state and municipal agencies and consulting firms whose employees are enrolled in graduate education.

Between June 1962 and May 1976, 132 M.S. and 22 Ph.D. degrees in Environmental Health Engineering and 20 M.S. and 5 Ph.D. degrees in Environmental Health Science were awarded. While graduate figures reflect enrollment spurts, approximately 17 M.S. and 1-2 Ph.D. diplomas are conferred annually. Virtually all graduates are employed in their field of training; and roughly 60 percent obtain jobs in the private sector. Former students now work in consulting engineering firms, regulatory agencies (state, regional, federal), sales, industry, operations of large-scale water treatment systems, education, and research. Placement is not a problem in Environmental Health at the University of Kansas, and the department maintains close contact with its graduates.

PROGRAM PROJECTIONS

The needs of the Environmental Health programs are basic: (1) continued training support to maintain the quality of the program for educating people for the scientific and practical work in this field, and (2) periodic funding for instrumentation and equipment necessary to keep pace with changing technology and legislative mandates (e.g., organic trace analysis in wastewater). Faculty stress that funding should not be used merely to increase the numbers of students but must be directed toward sustaining high caliber training.

The future of the Environmental Health programs is summarized well by Dr. McKinney:

> The Environmental Health programs at the University of Kansas have changed over the years to meet the needs of Kansas, which have mirrored many of the needs of the nation as a whole. Increased concerns are being directed towards air pollution in addition to water quality and solid wastes. The emphasis created by greater public participation and special interest groups in the different environmental issues is producing changes in the course contents. More emphasis is being given to socio-political relationships along with the technical information needed to produce engineering solutions. With more problems developing from poor operation of engineered systems, there is no doubt that further changes will occur in the future . . . The current program is a far cry from the early programs; but it exists because it has been built on those early programs. The future programs will be built on the current program and will reflect the desires of the faculty and the needs of the people.

* Source: Article by Dr. Ross McKinney in Environmental Education in Action II: Case Studies of Environmental Studies Programs in Colleges and Universities Today, edited by Clay Schoenfeld and John F. Disinger (in publication).

COURSE DESCRIPTION

CE 770 Concepts of Environmental Chemistry - Lectures on the application of fundamentals of aquatic chemistry to water purification and wastewater treatment. (2 s.h.)

CE 771 Environmental Chemical Analysis - A three hour laboratory introducing the basic chemical tests used in the environmental health field. (1 s.h.)

CE 772 Physical Principles of Environmental Engineering Processes - Physical principles of suspensions, kinetics, fluid flow, filtration and gas transfer are applied to various environmental physical processes. (3 s.h.)

CE 773 Biological Principles of Environmental Engineering Processes - A basic study of the micro-organisms of importance in sanitary engineering, namely, bacteria, fungi, algae, viruses, protozoa, rotifers, and crustaceans. Emphasis is placed on the reactions produced in dilute nutrient solutions and in mixed microbial systems as occur in natural water and wastes. (4 s.h.)

CE 774 Chemical Principles of Environmental Engineering Processes - Chemical principles of stoichiometry, thermodynamics and kinetics are applied to various chemical processes which have application to the environmental pollution control field. (3 s.h.)

CE 775 Marine Pollution - Marine chemistry and relations to pollution problems. Types of pollution and effects on the environment. Interrelation of the chemical, physical, geological, and biological parameters of the ocean and their interaction with pollutants. Special emphasis on problems of world-wide occurrence, international law, cooperation, and economics. (3 s.h.)

CE 776 Environmental Quality - Water quality requirement for irrigation, navigation, recreation, water supply, and wastewater disposal with emphasis on interrelationships in streams, rivers, and lakes. (3 s.h.)

CE 777 Industrial Water and Wastes - Treatment of water for industrial use with emphasis on chemcial precipitation and demineralization. Source and characteristics of industrial wastes, waste reduction by process change and good housekeeping and waste treatment by chemical and biochemical processes. (3 s.h.)

CE 778 Environmental Legislation - The study of the laws protecting the environment and how this legislation affects the practicing engineer and environmental scientist. (2 s.h.)

CE 779 Radiological Waste Treatment - Discussion of radioactivity, radioactive measuring devices, radiological safety, nuclear wastes, disposal systems and effect on the environment. (2 s.h.)

CE 872 Environmental Health Engineering Administration - Organization and operation of environmental health engineering programs at the federal, state, and local government levels. Laws, ordinances, and regulations for various aspects of sanitation. Statistics and epidemiological control of infectious diseases. (3 s.h.)

CE 874 Air Pollution - A study of air contaminants from all types of sources; deleterious effects of contaminants on plants, animals and materials; determination source strength; basic theory of control devices; air pollution surveys; and organization of control programs.

CE 875 Solid Waste Disposal - Study of refuse collection and disposal with emphasis on system analysis in organizing and operating collection systems, various methods of treatment, and economic evaluation of solid waste disposal problems. (3 s.h.)

CE 876 Wastewater Treatment Plant Design - Application of physical, chemical, and biological principles to the design of wastewater treatment processes for municipal wastewaters. (3 s.h.)

CE 877 Water Treatment Plant Design - Application of physical, chemical, and biological principles to the design of water treatment processes for domestic water supply from surface and groundwater resources and water reuse.

CE 878 Environmental Health Literature - Study and evaluation of the current literature in environmental health engineering. (1 s.h.)

CE 879 Environmental Health Research Seminar - Discussion of environmental health engineering research with emphasis on thesis research. (1 s.h.)

CE 973 Environmental Chemistry II - The chemical and biological aspects of special problems in water and sewage treatment, stream pollution, and industrial waste disposal. (2 s.h.)

CE 979 Advanced Topics in Environmental Health - Study of the latest ideas in environmental health. (2 s.h.)

INSTITUTION: UNIVERSITY OF LOUISVILLE (SPEED SCIENTIFIC SCHOOL)

PROGRAM: Environmental Engineering

DEPARTMENT: Chemical and Environmental Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Engineering (M.Eng.)

CONTACT: Dr. Charles Plank, Chairman
Department of Chemical and Environmental Engineering
Speed Scientific School
University of Louisville
Louisville, Kentucky 40208
(502) 588-6355

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This five year curriculum in environmental engineering began in 1971. The five year approach to engineering curricula plans has been operant for more than twenty-five years. At the end of the fourth year a Bachelor of Science degree is awarded, but this is not intended to be terminal. It is expected that unless the student has low grades (i.e., C- or lower) he/she will continue with the Master of Engineering program which is a post-baccalaureate professional curriculum.

One difficulty officials have encountered is the high employability of the students with B.S. degrees. High salaries make leaving the program following the baccalaureate program extremely attractive. Typical career opportunities exist with the Army Corps of Engineers, the state, and the Environmental Protection Agency. Although there has been no follow-up study conducted, it is believed that greater than 50 percent of the graduates accept positions with governmental agencies.

The Speed Scientific School provides an extensive amount of technical equipment allowing students hands-on experience. In the past this program was so multi-disciplinary that it did not have its own office and its chairman was directing three programs in addition to this one; Environmental Engineering was only marginally identifiable as an entity. This illusive appearance was thought to be the leading cause of sluggish enrollment figures. In 1977 this program was placed under the administrative aegis of the Chemical Engineering Department which was subsequently renamed the Chemical and Environmental Engineering Department. Currently, the chairman is dividing his attention between chemical engineering and environmental education and while the situation is greatly improved, the problem is not solved.

PROGRAM REQUIREMENTS

A student is eligible for admission to the undergraduate engineering programs on the basis of graduation from an accredited high school with at least fifteen standard units of credit of which twelve are academic, not vocational in nature. The twelve credits must be distributed among English, algebra, plane geometry, advanced mathematics, physics, chemistry and the remainder in history, social studies or foreign languages. In addition to those requirements, applicants must submit ACT or SAT scores. If sufficient aptitude is demonstrated, a student will be admitted to the freshman engineering program.

One hundred and twenty-two semester hours are required for a B.S. degree in Applied Science. First and second year students take all their courses in the Division of Pre-Engineering. The first year consists of introductory engineering courses and fundamental courses in chemistry, mathematics, and English. Second year students become more deeply involved in engineering principles course work, and they also decide what their major concentration will be. Students attend school year round. Seventy-four credits are required for completion of the pre-engineering core curriculum.

One of the strongest features of this curriculum is that each student must complete two sixteen-week internships and one eighteen-week internship with industry. These internships begin the summer after the second year of courses and run during the spring semester of the third year and the fall semester of the fourth year with academic quarters in between. The average co-op salaries are nearly twelve thousand dollars per year. Those individuals who successfully complete the program this far are awarded a B.S. degree and have the option of continuing for one more year and earning the M.Eng. degree provided they have a grade average of not less than a C minus.

Students who pursue the post-baccalaureate degree must write a thesis. An M.Eng. requires thirty-eight semester credits, including a thesis, beyond the B.S. degree requirements. Financial aid in the form of one teaching assistantship, five research assistantships, and one graduate service assistantship were received by post-baccalaureate persons.

It is important to note that it is the intent of the professional program that the student complete the entire five year plan culminating with the M.Eng. degree. Also, the M.Eng. degree is a professional degree awarded by the Speed Scientific School, not by the Graduate School of the university.

CURRENT FACULTY, STUDENTS, GRADUATES

There are four full-time faculty and four part-time adjunct faculty in environmental engineering. Approximately half of their efforts are expended on research, and half on teaching.

This program must recruit its students and goes about it in two ways with varying levels of success. Visits to high school science classes in Kentucky have been effective. Another very effective means of recruitment is a program called 'Department Days'. The Speed Scientific School features orientations to the various engineering concentrations during which time a potential major has the opportunity to visit four departments. This mode of recruitment is most effective among the students already enrolled in the pre-engineering curriculum.

Twenty-six third and fourth year students are currently pursuing the B.S. degree. There are an estimated thirteen people graduating each year with B.S. degrees. Fourteen people are enrolled full-time in the post-baccalaureate program with six M.Eng. degrees awarded in 1977.

Students appear to have good results in locating employment through the Placement Office, but the majority of the placements are made through personal associations established during internships. There has been no systematic follow-up of graduates to date; however, an estimate indicates that greater than 50 percent of the graduates of both levels find employment with the government.

PROGRAM PROJECTIONS

This program has just undergone a major upheaval and the chief concerns now are for program stabilization, healthy enrollment figure increases, and the establishment of an identity. A program official also felt a priority should be to establish firm ties with industrial concerns.

COURSE DESCRIPTION

Undergraduate courses:

11.300 Man and His Environment - Environmental ecology, water quality control, air quality control, solid wastes disposal, noise pollution, health effects of pesticides, and environmental laws and regulations. (3 s.h.)

11.302 Bio-Organic Chemistry - Biological aspects of organic chemistry as applied to environmental phenomena. (4 s.h.)

11.320 Atmospheric Pollution - Classification of industrial, automotive, domestic wastes and their effects on humans, livestock, plants, and materials. (3 s.h.)

11.321 Air Quality Measurement and Control - Methods of ambient and source sampling. Equipment and methods for pollution control. (3-4 s.h.)

11.330 Principles of Water and Wastewater Treatment - Theory of water and wastewater treatment with emphasis on physical, chemical and biological treatment methods and equipment. (3 s.h.)

11.331 Water Supply and Sewerage - Design, maintenance, construction and operation of municipal water supply and sewerage systems. (3-4 s.h.)

11.340 Fundamentals of Solid Waste Collection and Disposal - General aspects of solid waste management, legal and public relations aspects, nature and quantities of various wastes and their sources. (3 s.h.)

11.380 Principles of Environmental Planning - Political, sociological, and economic factors involved in improving environmental quality, techniques of determining needs of community and selection of alternative approaches, discussion of limitations of technology in meeting community health needs. (3-4 s.h.)

11.390 Occupational Health - Recognition, evaluation, and control of occupational hazards. Topics include disease and occupation; physical, chemical and mechanical causitive agents; TLV concept; sampling, analytical and survey procedures; protective equipment; ventilation; and ergonomics, and OSHA regulations. (3-4 s.h.)

11.400 Environmental Chemistry - Principles of chemistry and applications to the environment; generation and control of pollutants, interactions of contaminants with the environment, detection and measurement of pollutants, and treatment methods. (3 s.h.)

11.420 Environmental Meteorology - Thermodynamics and fluid mechanics relative to the transport and diffusion of contaminants released into the environment. Pollution-level forecasting. (3 s.h.)

11.430 Environmental Engineering Microbiology - Biology, microbiology and biochemistry. Activities of microorganisms and their effect on man and his environment. (3 s.h.)

11.440 Solid Waste Collection and Disposal Techniques - Collection equipment, methods and costs, new developments in refuse collection, and transfer methods. Major disposal methods, landfill site selection and design, fundamentals of incineration and composting. Trends in solid waste disposal and recycling. (3 s.h.)

11.450 Special Project in Environmental Engineering - A professional project open to students of demonstrated initiative and competence in self-study. (1-6 s.h.)

11.460 Environmental Noise Measurement and Control - Measurement of general environmental noises, measurement equipment, data collection and analysis, measurement of noises generated by highways, airports, railroads, etc. Effects of noises on quality of environment and on humans. (3-4 s.h.)

11.515 Environmental Health Physiology and Toxicology - Effects of environmental hazards such as toxic chemicals, radiation, air and water pollutants, on the human body. (3 s.h.)

11.520 Theoretical Meteorology and Oceanography - Dynamics and thermodynamics of the atmosphere and the oceans. Numerical forecasting. (3 s.h.)

Post-baccalaureate courses:

11.520 Theoretical Meteorology and Oceanography - Previously described. (3 s.h.)

11.532 - 11.533 Design of Water Quality Control Facilities I, II - Design of water treatment plants, sizing of equipment, application of recent developments. Design of primary and secondary treatment plants, tertiary treatment processes and equipment. (3 s.h. each)

11.534 Industrial Processes and Waste Treatment - Survey of modern industrial processes with emphasis on use, generation, control, and treatment of environmental hazards. (3 s.h.)

11.535 Measurement of Environmental Quality - Laboratory and field methods for analysis of environmental quality: water, air and solid wastes. (3-4 s.h.)

11.536 Laboratory Modeling of Wastewater Treatment Processes - Purposes, procedures, and principles of laboratory feasibility analysis for treatment of municipal and industrial wastewaters. (3-4 s.h.)

11.550 Disposal of Radioactive Wastes - Methods of ultimate disposal of nuclear waste products, selection of methods, site, long and short term safety considerations, costs, possible effects on environment. (3 s.h.)

11.580 Systems Analysis for Environmental Planning - Application of various types of mathematical models to environmental health planning, input data collection, determination of what comprises a meaningful solution, limitation of systems techniques in environmental health planning, linear, non-linear, and dynamic programming models. (3 s.h.)

11.620 Air Quality Engineering I - Covers general aspects of pollution sources, pollutant transport and pollutant receptors. (3 s.h.)

11.621 Air Quality Engineering II - Applications of air quality engineering principles to advanced treatment and control procedures. Legal and administrative control procedures. (3 s.h.)

11.622 Atmospheric Chemistry - Application of chemical principles to reactions taking place in the atmosphere. Emphasizes equilibrium, thermodynamic, and kinetics concepts. Combustion theory. (4 s.h.)

11.623 Atmospheric and Oceanic Diffusion - Statistical theory of turbulence and phenomena related to problems in diffusion and dispersion of contaminants in the atmosphere, oceans, lakes, rivers, estuaries. Urban pollution modeling. Thermal pollution. (3 s.h.)

11.630 Physico-Chemical Treatment of Water and Liquid Wastes - Physical and chemical nature of water and waste waters, and application to treatment and water quality characterization. Parameters and methods for analysis. Conventional treatment methods, e.g., flocculation, carbon adsorption, and advanced techniques, including oxidation, electrodialysis, and phosphate removal. (3 s.h.)

11.631 - 11.632 Water Quality Engineering I, II - Treatment of water for industrial use with emphasis on chemical precipitation and demineralization. Treatment of industrial waste by chemicals and biological processes. (3 s.h. each)

11.640 - 11.641 Solid Waste Engineering I, II - Storage and collection methods, disease relationships, transfer facilities, design and cost analysis of disposal systems. Systems analysis in planning and management of solid wastes. (3 s.h. each)

11.680 Solid Waste Applications of Systems Analysis - Application of systems approach to planning and design of refuse collection and disposal systems, including linear and non-linear programming, dynamic programming and simulation techniques. (3 s.h.)

11.681 - 11.682 Environmental Health Planning I, II - Environmental design; research and program implementation; field studies developed in contact with local and state agencies. Quantitative analytical and projective methods applied to environmental planning problems. Development and evaluation of models, prototypes, analogs, and solutions. (3 s.h. each)

INSTITUTION: UNIVERSITY OF MAINE - ORONO

PROGRAM: Sanitary Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science degree in Civil Engineering in the areas of Sanitary, Soils, Structural, and Highway Engineering
Doctor of Philosophy in Sanitary Engineering

CONTACT: Dr. Willem I. Brutsaert
Civil Engineering Dept.
355 Aubert Hall
University of Maine
Orono, Maine 04473

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The University of Maine's sanitary engineering program since inception during the mid-1960s has been predominantly oriented toward water topics. The unique geographical location of this land-grant institution provides excellent outdoor laboratory opportunities for students interested in either lake or water resources research.

At the undergraduate level, students can take basic sanitary engineering courses which concentrate on the theory, design, and control of water treatment plants and unit process for water, air, and land pollution abatement. Students are also offered courses in both chemistry and microbiology in sanitary engineering. In addition, courses are offered in the areas of hydrology, hyraulics and soils engineering.

Graduate courses are available in water resources, engineering, radiological health, industrial wastes, public health engineering, and design of both water treatment and wastewater treatment plants. All graduate students are required to participate in a sanitary engineering seminar during which current research topics are both individually presented and discussed.

PROGRAM REQUIREMENTS

In order to enter the M.S. program, applicants are usually required to have a B.S. degree in Civil Engineering, from an accredited institution. Prospective applicants who do not meet this requirement may have to take courses for no graduate credit.

For the Master of Science degree, a minimum of thirty semester hours, including thesis credits, is required. All M.S. candidates are required to prepare a thesis as well as complete a minimum of 12 hours (exclusive of thesis) of 200 and/or 300 level graduate course work as a part of the thirty semester hour requirement. The thesis credit amount is a minimum of six hours.

The Doctor of Philosophy degree in Sanitary Engineering emphasizes original research and represents approximately 50 percent of the program beyond the B.S. degree. No more than 30 semester hours of transfer credit is accepted and the degree must be completed within four years of admission to candidacy. The dean of the graduate school appoints the student's advisory committee and the student's major or thesis advisor serves as chairperson. Competence in one foreign language is required and proficiency is determined by a written examination involving translation of technical literature.

Graduate students can obtain financial assistance from such sources as: Department teaching or research assistantships; highway fellowships for State Highway Commission employees; and various other fellowships and scholarships.

CURRENT FACULTY, STUDENTS, GRADUATES

The Civil Engineering Department has a total of 14 faculty positions of which five are concerned with sanitary engineering topics. All five teaching positions are staffed with two sanitary engineers (one with a water chemistry background), one hydrologist, one water resources engineer, and an environmental engineer with a coastal research background. One associate faculty member is director of the Water Resources Center with a special interest in Lake Systems and fresh water quality problems.

There are currently (fall, 1977) fourteen full time students enrolled in the program of whom two are female. Some students have entered the M.S. program with microbiology or geology backgrounds. Normally, an average of five to seven students receive the M.S. or Ph.D. degree annually.

Few students (one out of ten) continue to receive their doctorates at other educational institutions and those that have continued have gone to Purdue among others. Officials have stated that one hundred percent of the M.S. students have found employment and about seventy-five percent have obtained jobs in the private sector, mostly consulting firms. The other twenty-five percent have found public sector jobs with such agencies as the State Department of Environmental Protection, the U.S. Environmental Protection Agency, and various state planning agencies.

PROGRAM PROJECTIONS

The sanitary engineering program at the University of Maine is expected to expand into a broader environmental engineering program with emphasis on the study of coastal and inland waters. The Master of Science in Civil Engineering will allow students to select options in the following areas: sanitary engineering; coastal engineering; hydrology; and water resources engineering. During 1978 two additional faculty members are expected to be recruited for this expansion. One environmental engineer with research backgrounds in coastal processes and estuaries problems will be hired by the fall term of 1978. The other addition will be a sanitary engineer with research expertise in water chemistry and this second person is expected to be hired by the spring term, 1978. Generally, program officials expect environmental programs to stay at a stable level and maintain a status quo. However, the University of Maine program is expected to recruit additional students who are interested in water resources study relating to coastal and inland waters.

COURSE DESCRIPTION

Graduate courses:

200 Applied City and Regional Planning - The practice of city and regional planning and the preparation of regional and urban plans. (3 s.h.)

230 Water Resources Engineering - Development, control, and engineering of water resources systems. (3 s.h.)

240 Radiological Health - Atomic structure, radioactivity, Decay Law, interaction of radiation with matter, sanitary engineering application of radiation and radioactive waste disposal, and other topics. (3 s.h.)

320 Physicochemical Processes for Water Quality Control - Principles of physical and chemical unit operations applied water and wastewater treatment. (3 s.h.)

322 Biological Processes for Wastewater Treatment - Principles of biologic unit processes applied to wastewater treatment. (3 s.h.)

323 Industrial Wastes - Study of the principles and practice of industrial waste treatment. (4 s.h.)

324 Public Health Engineering - Subjects include epidemiology, housing, air pollution, radiological health, and others. (3 s.h.)

330 Sanitary Engineering Design I and II - The functional design of a water treatment plant, and in the second part, of a wastewater plant. (3 s.h.)

INSTITUTION: UNIVERSITY OF MICHIGAN

PROGRAM: Environmental Sciences Engineering

DEPARTMENT: College of Engineering (interdepartmental)

DEGREE: Bachelor of Science in Engineering (B.S.E.)

CONTACT: Dr. Jack A. Borchardt
Dr. D.E. Briggs
Environmental Sciences Engineering
College of Engineering
University of Michigan
Ann Arbor, Michigan 48103
(313) 764-6487

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Sciences Engineering program was established in 1971 at the University of Michigan "in recognition of the increasing need for trained and skilled engineers to undertake problem analysis and problem solution for environmental problems which cut across traditional engineering disciplines." Coursework taken in this baccalaureate program ranges from engineering and traditional physical sciences to the natural and social sciences. Within individualized plans of study, students fulfill a program option requirement (21-24 hours) designed to develop a problem-solving proficiency in some area of environmental sciences engineering. Option topics include: air quality, combustion processes, environmental chemistry, land management, noise control and abatement, power generation and distribution, radiological hazards, remote sensing of the environment, urban environmental problems, waste management, and water quality. Job opportunities depend on one's direction of coursework. The interface between engineer and environmentalist served by the environmental sciences engineer (see next page for model) is an important one in our technological society.

The programs interdisciplinary housing within the College of Engineering gives students access to a wide variety of laboratories. Faculty note that funds for equipment maintenance are scarce, but Michigan manages to remain at the vanguard of research inspite of the difficulties imposed by low funding. The program in Environmental Sciences Engineering receives no outside funding and has no grant money. Individual faculty members who participate in this program do receive grant monies for projects conducted under the auspices of their home departments.

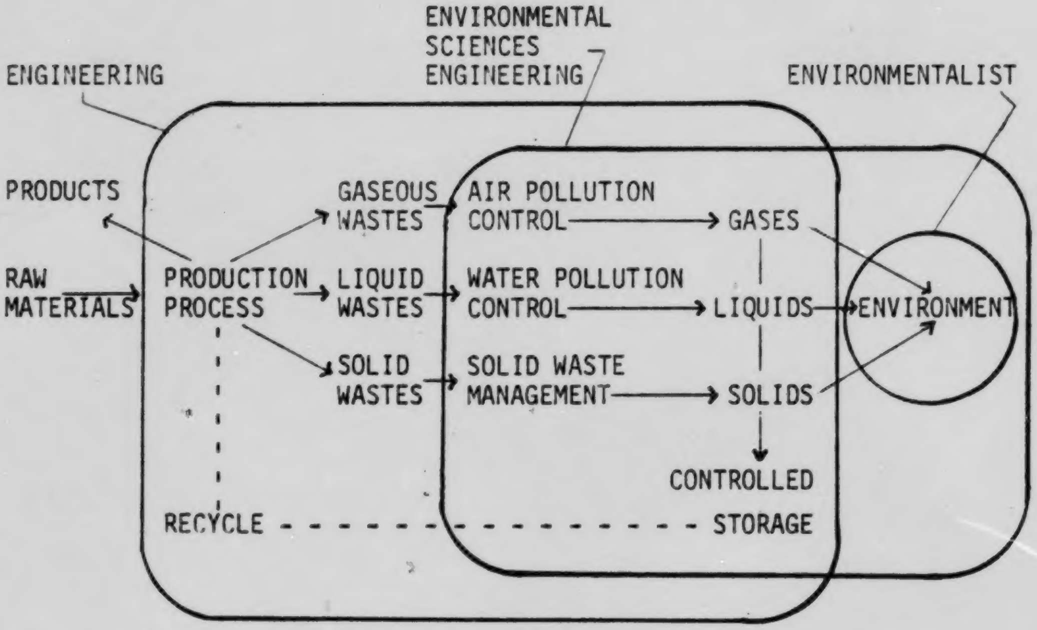

ENVIRONMENTAL SCIENCES ENGINEERING
ENGINEERING
ENVIRONMENTALIST
PRODUCTS
RAW MATERIALS
PRODUCTION PROCESS
GASEOUS WASTES
LIQUID WASTES
SOLID WASTES
AIR POLLUTION CONTROL
WATER POLLUTION CONTROL
SOLID WASTE MANAGEMENT
GASES
LIQUIDS
SOLIDS
ENVIRONMENT
CONTROLLED STORAGE
RECYCLE

Diagram of the Role of the Environmental Sciences Engineer.

PROGRAM REQUIREMENTS

In addition to the Program Option requirements providing the student with some specialization, undergraduate majors in Environmental Sciences Engineering must take a set of College core courses (mathematics, physics, chemistry, humanities), an engineering sciences core, basic environmental sciences courses (chemistry, atmospheric and oceanic sciences, geology, biology), and a senior seminar in Environmental Sciences Engineering. The B.S. degree requires 128 semester hours.

CURRENT FACULTY, STUDENTS, GRADUATES

There are no faculty officially assigned to the Environmental Sciences Engineering program though one person from the College of Engineering does serve as program advisor. As of Winter 1977, there were 79 full-time students enrolled from within the College and by transfer from science and natural resources programs. (In recent years, approximately nine students have entered the program by transfer for every seven entering from freshman status.) Ten to twelve students complete the degree annually with fluctuations due in part to social pressures to study the environment.

In the past, roughly equal percentages of graduates have entered government and private sector jobs; but an influx of consulting firms will undoubtedly upset that balance in favor of the business world. The problem-identification and problem-solution emphasis of the program has not always been well recognized and appreciated by employers; and therefore, the engineering background of the students has often assumed great importance in job placement. Approximately 20 percent of the Environmental Sciences Engineering graduates pursue advanced degrees.

Of the 101 graduates of this program since its inception in 1971, program options (or concentrations) selected were as follows:

Program Option	Number	Number Oriented Toward Civil Engineering
Water and Water Related	52	52
Land	12	12
Waste Management and Control	5	5
Air Quality and Pollution Control	8	
Atmospheric-Oceanic Sciences	6	
Combustion	4	
Environmental Chemistry	4	
Nuclear	4	
Electric and Instrumentation	3	
General Environmental	4	4
Others	3	
	105*	73

* Four students had program options listed under two titles.

PROGRAM PROJECTIONS

The need for financial support for the Environmental Sciences Engineering program parallels that of many such programs. According to faculty personnel, programs built with training grants from industry and government are now floundering unless their home institutions have chosen to absorb their expenses. Nonetheless, this program enjoys strong and stable student enrollment and continues to provide those students with basic engineering skills coupled with a trained awareness of environmental constraints and design solutions.

COURSE DESCRIPTION

Atmospheric and Oceanic Science:

203 The Oceans - Elementary descriptions of the oceans, their characteristics, and behavior; the sea as a world resource and as an influence on civilizations. (3 s.h.)

300 The Atmosphere - Technical survey of atmospheric science designed especially for students studying science and/or engineering. Atmospheric structure and circulation; composition and controlling processes; determinants of climate and climatic change; topics related to human influences on the atmosphere and atmospheric influences on human activities. (3 s.h.)

304 Atmospheric and Oceanic Sciences I - The various aspects of meteorology and oceanography. Emphasis is placed on the geophysical and geochemical origins, composition, structure, and motions of the atmosphere and oceans. (3 s.h.)

305 Atmospheric and Oceanic Sciences II - A continuation of 304, with emphasis on the description and physical bases of geophysical fluid wave motions, and other physical and biological processes, introducing the students to various aspects of aeronomy, meteorology, and oceanography. (3 s.h.)

Civil Engineering:

420 Hydrology I - The hydrologic cycle; precipitation, its causes, distribution, and frequency; snow melting processes; evaporation; transpiration; infiltration; aquifers, well hydraulics; normal and low flows; magnitude and frequency of floods; storm sewer capacities; flood routing; storage requirements for flow augmentation; measurement of river discharge. (3 s.h.)

Engineering:

480 Seminar in Environmental Sciences Engineering - Examination of critical environmental problems related to modern technology, with emphasis on development of practical solutions. The particular problem(s) studied in any given term will be selected to take advantage of the special knowledge and interests of the student, who will contribute to the development of solutions and alternatives by oral and written presentation. (3 s.h.)

INSTITUTION: UNIVERSITY OF MICHIGAN

PROGRAM: Industrial Hygiene and Air Pollution

DEPARTMENT: Environmental and Industrial Health

DEGREE: Master of Public Health (M.P.H.)
Master of Science in Industrial Health (M.S.)
Doctor of Public Health (Dr. P.H.)
Doctor of Philosophy in Industrial Health (Ph.D.)

CONTACT: Dr. Dohrman H. Byers
Department of Environmental and Industrial Health
School of Public Health
University of Michigan
Ann Arbor, Michigan 48104
(313) 764-2594

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

While the programs in Industrial Hygiene and Air Pollution at the University of Michigan both examine the human exposure to contaminants, the former course of study emphasizes the industrial worker's occupational environment while the latter focuses on the general population's total daily exposure to air pollution. Students in Industrial Hygiene are trained in the recognition, measurement, evaluation, and control of occupational exposures to chemical and physical hazards. Courses cover sources of exposure, toxicity of materials, effects of physical agencies, application of legal and professional standards, and engineering and administrative methods of achieving safe working conditions. Students seeking degrees with emphasis in air pollution concentrate their studies in the investigation, evaluation, and control of community air pollution problems; their courses outline sources, nature, properties, and effects of pollutants as well as the patterns of pollution and the engineering and other methods of controlling these.

The applied-science training offered through either the Industrial Hygiene or Air Pollution areas of concentration is characteristically general--specialization within each field comes with one's job experience. All students complete a field course on in-plant studies in which students visit 8-10 industires for one day each and identify the industrial health measures which must be taken to insure occupational safety.

Research in the department includes a contract with the Chlorine Institute and a ventilation study for a private company. The staff recently completed a six-criteria documant for the National Institute for Occupational Safety and Health. Additional funding from industry helps to support student research. The facilities for teaching and research total eight well-equipped laboratories and basic field instrumentation. The department conducts a number of workshops and short courses for industrial and government agency personnel; these include a NIOSH-AIHA sponsored five-day course for non-professional management people to acquaint them with the field and meetings of 30-50 industrial hygienists and industrial physicians from major corporations to discuss mutual problems.

PROGRAM REQUIREMENTS

The Master of Public Health degree (M.P.H.) requires enrollment in the School of Public Health. The course of study may vary from 36 credit hours to 60 credit hours, depending on prior experience and preparation; this represents from two and one-half to five terms as a full-time student at the school. Two or more years of experience in a health-related field subsequent to completion of the bachelor's degree is required for admission to the minimum 36 hour degree program. For students with no prior acceptable experience, the 60 hour degree program is required. For intermediate experience some adjustment in requirements may be made. All students in degree programs in the School of Public Health are required to complete the "core course", which is a series of courses designed to give a basic knowledge of public health methods and practices as well as an overview of the comprehensive aspects of this professional field.

The M.S. degree in Industrial Health allows the student to elect study in industrial hygiene or air pollution. The actual course of study is supervised in the School of Public Health and is comprised of most of the same courses as for the M.P.H. There is no experience requirement for the M.S. program. The student must complete 36 credit hours which usually take two and one-half to three terms. The Public Health "core course" is not required but equivalent study in biostatistics and epidemiology usually is required.

The Doctor of Public Health (Dr. P.H.) and the Doctor of Philosophy (Ph.D.) in the fields of industrial hygiene and air pollution share essentially the same requirements. The master's degree is not required, but all requirements of that degree must be fulfilled to qualify as a doctoral candidate. Students must complete a research project and prepare and defend an acceptable dissertation. The doctoral degrees usually take about three years beyond the master's requirements.

Applicants for any of the above degrees must have completed a bachelor's degree from an acceptable school (3.0 GPA requirement unless special ability or circumstance). A science background is desirable including a course in college-level mathematics, physics, and chemistry (analytical and organic). Some biological science study is helpful.

CURRENT FACULTY, STUDENTS, GRADUATES

There are three full-time faculty in Air Pollution and Industrial Hygiene; but faculty from other areas in the Environmental and Industrial Health department and other departments teach courses in epidemiology, biostatistics, bioengineering, toxicology, computer technology, radiological health, and water quality. Of the forty-five full-time students in Industrial Hygiene, ten are doctoral candidates. Enrollment in Air Pollution is drastically low -- one M.S. and one Ph.D. student. The program growth in Industrial Hygiene due to legislation and job opportunities stands in sharp contrast to the decline in the Air Pollution area due to minimal availability of student financial aid. The program graduates an average of twenty students annually with yearly fluctuations attributed to the one-year time frame taken by M.S. students compared with the two-year residence required to complete the M.P.H. The number of graduates is increasing slightly despite the University's "no-growth" policy for achieving optimum levels for facilities, student-faculty ratios, and overall quality, not quantity.

Virtually all students are employed in the field with 90 percent taking jobs in the private sector. Salary inequities between government and private-sector positions have contributed to a growing shift away from public jobs, except for those students with a "social conscience", according to department personnel. Employment opportunities exist in government at all levels, industries with air pollution problems, consulting firms, and universities. Financial assistance to 15-16 students comes mostly from a NIOSH training grant, and some from industrial grants, the Environmental Protection Agency, and the university.

PROGRAM PROJECTIONS

Manpower needs in Industrial Hygiene will assure the employability of graduates with this specialization for the next decade or so. The Department is presently searching for two additional faculty--one engineer or chemist for Industrial Hygiene/Air Pollution and one physician (M.D.) for Occupational Medicine. The increase in non-medical faculty from three to four has been approved. To comply more nearly with school policy, the program will be limiting enrollment to a total of about 35 and scaling down present levels over a two-year period. No major curriculum changes are expected.

COURSE DESCRIPTION

Environmental and Industrial Health courses:

500 Environment and Health - Environmental factors affecting health and disease and major related principles of sanitary science employed in modification of the environment for the promotion of health. Primarily for students other than those majoring in environmental health. (2 s.h.)

501 Environmental Physiology - The effect of environmental stresses on human physiology. Mechanism of production of disease through toxic materials in air, food, and water. Physical variants of temperature, air pressure, electromagnetic energy, and vibration in the production of disease states. (2 s.h.)

502 Principles of Environmental Health - Principles of engineering and science used in the control of man's environment. Includes water supply and treatment, sewerage, wastewater treatment, plumbing and cross connections, swimming pools and bathing areas, refuse collection and disposal, industrial hygiene, ventilation, noise, illumination, community air pollution, radiological health principles, food and milk sanitation, insect and rodent control, housing. (3 s.h.)

504 Computer Applications in Environmental Health - Introduction to data processing, information storage and retrieval systems, and computer programming of environmental health problems.

508 Radiation in the Environment - The biological effects of radiation as a basis for radiation protection standards. Principles and methods of protection against radiation hazards, with emphasis on natural and man-made sources of radioactivity. A comparison of radiation with other toxic agents in the environment. (2 s.h.)

511 Equipment Sanitation Standards, Design, and Evaluation - Principles of sanitation and design, selection of materials, and construction of equipment, such as employed in processing, vending, and dispensing of food; swimming pools and other installations; technical methods of evaluation--bacteriological, physical, chemical, thermodynamic, radioactive, hydraulic; development, implementation, and administration of national standards for industry and local and state regulatory agencies.

512 Environmental Health Administration Practice - Modern concepts, scope, and objectives of environmental health practice. Responsibilities of personnel. Determination of community environmental health problems and needs. Program planning, emphasis, and evaluation. Principles, content, methods, and tools. (2 s.h.)

513 Advanced Environmental Health Administrative Practice - Administration of environmental health programs and organizations. Organizational structure, forces of management, administrative controls, personnel and financial management, legal aspects. (2 s.h.)

517 Environmental Health in Developing Areas - Designed primarily to give individual attention to small groups of foreign students with specific problems in the technical and administrative practices of environmental health. (2 s.h.)

521 Environmental Planning - Constructs an analytic framework within which environmental (health) policy and planning are evaluated. Emphasis on the design and concept of social cost and pollution damage functions and their economic, social, and health implications. (3 s.h.)

531 Environmental Chemistry - Integration of selected principles in physical, organic, and biological chemistry to the study and control of the human environment. Emphasis to demonstrate the underlying difference and unity among various environmental phenomena. (3 s.h.)

533 Fundamentals of Instrumental Methods of Chemical Analysis - Fundamental principles, operation, application of modern instruments in scientific analysis. Instruments include emission, ultraviolet and infrared spectroscopy, X-ray emission and diffraction, gas chromatography, mass spectroscopy, and others. Emphasis on application to environmental and medical fields. (3 s.h.)

541 Essentials of Toxicology - Biological response of man and experimental animals to toxic compounds and factors which influence this response. Detoxication mechanisms. The toxicity of selected groups of chemical compounds. (2 s.h.)

542 Industrial Toxicology - Continuation of EIH 541. Topics include mechanisms of selective toxicity, toxicity and metabolism of aromatic compounds. The relationship of chemical structure to biological activity. (2 s.h.)

543 Ecological Toxicology - Dynamics of toxic substances in the environment. The effects of toxic substances on individuals, populations, and communities of organisms presented in an ecological context. (3 s.h.)

544 Methods in Toxicology - Methods of evaluating acute and chronic toxicity of solids, liquids, and vapors. Techniques of establishing controlled exposures to toxic materials. Directed individual investigations of the toxicity of assigned materials. (3 s.h.)

551 Principles and methods of Industrial Health - Organization of industrial health services in government and in industry. Public health approach to industry. Representative industrial health situations. For public health administrators, sanitary engineers, sanitarians, nurses, educators, and others. Primarily for students not specializing in industrial health. (2 s.h.)

560 Principles of Community Air Pollution - Discussion of economic, nuisance, and health aspects, emphasizing sources, causes, effects, control measures, and the organization and administration of community control programs. (3 s.h.)

561 Health Factors in Air Pollution - Acquaints the student with relationships and applications of physiology, toxicology, epidemiology, bacteriology, and radiation to the field of air pollution. (3 s.h.)

606 Environmental Health Seminar - Seminar reading and discussion in the broad and specialized areas of environmental health. (1-2 s.h.)

650 Industrial Hygiene - Basic concepts of industrial hygiene and occupational health hazards. Physical and chemical stresses of the industrial environment; sources; effects, measurement, evaluation, and control of exposure. (3 s.h.)

651 Industrial Hygiene Control - Control methods other than ventilation for conservation of industrial health, such as substitution and personal protection, with reference to special operations and industries. (2 s.h.)

652 Air Sampling and Analysis - Laboratory and field methods and equipment for appraisal of occupational environmental conditions. Such procedures are related to dusts, fumes, vapors, gases, mists, noise, odors, illumination, temperatures, and humidity. (2 s.h.)

653 Industrial Hygiene Sampling and Analysis - A continuation of EIH 652 with inclusion of analysis of biological specimens. (2 s.h.)

659 In-Plant Studies - Practicum experience centered around trips to industries (8-10) and evaluation of industrial hygiene problems and solutions. (2 s.h.)

660 Sampling Methods in Air Pollution - Familiarizes the student with various instruments and techniques for determining amount and nature of air pollutants in stacks and in the community, together with application of these methods. (3 s.h.)

662 Air Pollution Seminar - Special assignments concerning evaluation and control of air pollution problems. Second term (EIH 663) is a continuation of first term. (2 s.h.)

665 Analysis of Air Pollutants - Principles and methods of operating automatic field and laboratory instruments and of chemical analyses of air pollutants; laboratory exercises using representative instrumentation and selected analytical methods. (3 s.h.)

666 Air Pollution Chemistry - Second half, E.H.: the physical-chemical theory, and application of analytical processes for the determination of air pollutants and their reactions in the natural environment. Systems for the analysis of trace metals and organics. Theory of interaction in light and air pollutant molecules for continuous monitoring. (3 s.h.)

862 Advanced Seminar in Air Pollution - Assignments in depth of problems associated with air pollution. Selected guest discussion leaders. For pre-doctoral students. (1-2 s.h.)

INSTITUTION: UNIVERSITY OF MINNESOTA

PROGRAM: Environmental Health

DEPARTMENT: School of Public Health

DEGREE: Masters of Public Health (M.P.H.)
Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Mr. Rexford D. Singer
1160 Mayo
University of Minnesota
Minneapolis, Minnesota 55455
(612) 373-8080

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

In 1935, health officers of adjacent states selected the University of Minnesota to train public health personnel under provisions of the Social Security Act. Curricula for the training of health officers and public health engineers were established at that time. The mission of the School of Public Health is to provide the interrelated functions of education, research, and service in order to promote the public welfare.

The decision to apply directly to the School of Public Health for study toward a professional degree (M.P.H.) or to the Graduate School for study toward an academic degree (M.S., Ph.D.) will depend upon the applicant's chosen program of study, long-term career needs and expectations, prior experience and academic preparation, and future academic plans.

The student may obtain specialized training in air pollution, public health biology, institutional environmental health, occupational health and safety, radiological health, or water hygiene.

PROGRAM REQUIREMENTS

Applicants for the M.P.H. degree should possess a graduate degree from an acceptable institution in a discipline relevant to public health or a Bachelor's degree from an acceptable institution with a minimum of two years appropriate professional experience. Three letters of recommendation are also required.

Programs of study leading to the M.P.H. degree are offered in 12 areas, one of which is environmental health.

A program of study and research leading to the M.S. or Ph.D. degree, administered through the Graduate School, may be elected with a major or minor in environmental health. These programs are designed for those who lack prior professional experience or those planning a career in teaching or research.

Appropriate course work is selected by the student in consultation with the student's advisor and in accordance with the requirements of the specific program of study. Specialization within Environmental Health include air pollution, institutional environmental health, occupational health and safety, public health biology, radiological health and water hygiene.

Students are expected to take required core courses as a part of their degree program. It also is expected that students will take courses in administration, biometry, epidemiology, and toxicology. Depending on the degree and the option chosen by the student, a thesis may or may not be required.

CURRENT FACULTY, STUDENTS, GRADUATES

The program includes eight full-time and ten part-time faculty members. In addition, lecturers from a variety of industries and agencies participate in the course work.

Approximately 40 new students are admitted to the program each year. Some form of financial assistance is received by 80 to 90 percent of the students. One-fourth of this year's class is female. Student enrollment is 50 full-time and 30 part-time. There are 40 graduates per year.

PROGRAM PROJECTIONS

At some time in the future, the master's program may become more than one year in length and field work may be required.

ADDITIONAL INFORMATION

The University of Minnesota is directing a $2.7 million, five-year grant from the National Institute for Occupational Safety and Health. The University of Iowa, Mayo Clinic, St. Paul-Ramsey County Hospital, and University of Minnesota-Duluth are also members of the consortium.

This grant makes the consortium one of nine centers for the occupational health development among medicine, RNs, industrial hygiene, safety specialists. It is an outreach and degree program which began September 30, 1977. Traineeships will be awarded, industrial contacts developed and equipment purchased.

COURSE DESCRIPTION

Note: Other course work in a wide range of subject areas such as water, wastewater, solid wastes, energy, meteorology, particle technology, noise, law, planning, limnology, ecology, geohydrology, food science, etc., are available to qualified students through other departments and schools within the University including but not limited to Agricultural Engineering, Architecture, Chemical Engineering, Civil Engineering, Earth Sciences, Ecology and Behavioral Biology, Entomology, Environmental Engineering, Food Science and Nurtition, Mechanical Engineering, Law, Pharmacology, Plant Pathology, Public Affairs, Radiology, and Soil Science.

5155 Environmental Health - Methods of promoting man's health by controlling environmental factors relating to air, water, food, wastes, accidents, housing, radiation, industrial hygiene. (4 q.h.)

5159 Seminar: Environmental Health - (arr. q.h.)

5161 Administration of Environmental Health Programs - Administrative organization of environmental health activities. (3 q.h.)

5171 Environmental Microbiology - Survival, dissemination, transportation, and significance of microorganisms in the environment; application of principles to environmental health problems. (3 q.h.)

5177 Public Health Biology - Introduction to plant and animal forms important in environmental health; biological aspects of water supply, waste treatment, stream pollution, and special phenomena related to human disease transmission. (3 q.h.)

5180 Topics in Air Pollution - Selected readings in air pollution with discussion based on these readings. (cr. arr.)

5181 Introduction to the Air Pollution Problem - History, sources, controls, effects, surveys, legal aspects, administration of programs. (3 q.h.)

5182 Air Pollution Controls and Surveys - Public health engineering approach to air pollution controls and surveys. (3 q.h.)

5183 Problems of Air Pollution Control - Special supervised studies involving laboratory and field investigation procedures; review of pertinent literature. (arr. q.h.)

5184 Air Analysis - Laboratory and field exercises involving air flow calibration, dynamic calibration of field equipment for analysis of air contaminants, respirable mass sampling, dust counting and sizing, and instrumentation for measuring physical environmental stresses. (3 q.h.)

5185 Air Analysis II - Laboratory and Field exercises involving sampling and analysis techniques for stack sampling and for ambient air monitoring. Group surveys of air pollution problems and special projects. (3 q.h.)

5190 Topics in Injury Control - Directed readings and reports on selected problem areas in injury control. (cr. arr.)

5194 Occupational Safety - Occupational safety procedures, environmental controls to reduce injuries on and off the job, safety program development and administration. (2 q.h.)

5200 Topics in Radiological Health - Selected readings in radiological health with discussion based on these readings. (cr.arr.)

5201 Measurement and Application of Ionizing Radiation - Introduction to principles of measurement and use of radiative sources; emphasis on health hazards. (3 q.h.)

5202 Environmental Radioactivity - Sources, measurement, evaluation, and control of environmental radioactivity; hazards to general population. (3 q.h.)

5203 Low-level Radioactivity Measurements - Lectures and laboratory on the assay of low levels of radioactivity in environmental samples. (3 q.h.)

5210 Topics in Occupational Health - Selected readings in occupational health with discussions based on these readings. (cr. arr.)

5211 Industrial Hygiene Engineering - Concepts and techniques used in occupational health; emphasis on fieldwork, evaluation of potential hazards, and preventive techniques. (4 q.h.)

5212 Ventilation Control of Environmental Hazards - Theory and application of exhaust ventilation in control of airborne environmental hazards; principles of exhaust hoods, air moving devices, gas cleaning devices; demonstration of measurement techniques; relationship of hazards and process to ventilation design criteria. (3 q.h.)

5213 Public Health Aspects of Toxic Products - Problems of protecting industrial workers and private consumers from useful but potentially harmful products; product testing programs and administration; labeling problems. (2 q.h.)

5215 Applied Occupational Toxicology - Basic toxicology and physiology with emphasis on environmental contaminants. Special consideration of inhalation toxicology of the work environment and air pollution. (3 q.h.)

5232 Environmental Health and Safety in Health Care Facilities II - Ventilation; water supply; plumbing; solid and liquid waste systems; and other environmental engineering problems. (4 q.h.)

5240 Topics in Water Hygiene - Selected readings and discussions of problems relating to the health aspects of water supply and waste water systems. (arr. q.h.)

5241 Environmental Health Aspects of Water Supply - Role of water in human health; physical, chemical, and biological characteristics; evaluation of source, treatment, and distribution systems. (3 q.h.)

5242 Environmental Health Aspects of Groundwater Systems - Introduction to groundwater geology, quality, and treatment; well design, construction, and maintenance; special references to public and environmental health problems. (2 q.h.)

5244 Environmental Health Aspects of Waste Water Systems - Role of liquid wastes in human health; physical, chemical, and biological characteristics; evaluation of source, treatment, and disposal facilities. (3 q.h.)

5261 Environmental Toxicology - Application of toxicology to environmental problems; interpretation and evaluation of data, assessment of potential health hazards, and approaches to solution of problems. (3 q.h.)

8150 Research in Environmental Health - Opportunities for qualified students to pursue research in the importance of environmental stresses on human health. (cr. arr.)

8170 Research in Environmental Biology - (cr. arr.)

8180 Research in Air Pollution - (cr. arr.)

8190 Research in Injury Control - (cr. arr.)

8200 Research in Radiological Health - (cr. arr.)

8201 Radiation Dosimetry - Radiant energy absorption in liquids, gases, and solids; absorption in biological systems. (3 q.h.)

8210 Research: Occupational Health - Cr. arr.)

8218 Field Problems in Occupational Health - Guided evaluation of potential occupational health problems; recommendations and design criteria for correction if indicated. (3 q.h.)

8240 Research: Water Hygiene - (cr. arr.)

8260 Research: Environmental Toxicology - (cr. arr.)

INSTITUTION: UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

PROGRAM: Environmental Management and Protection (EMP)

DEPARTMENT: Environmental Sciences and Engineering

DEGREE: Master of Science (M.S.)
Master of Science in Public Health (M.S.P.H.)
Master of Public Health (M.P.H.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Russell F. Christman, Professor and Chairman
Department of Environmental Sciences and Engineering
School of Public Health
The University of North Carolina
Chapel Hill, North Carolina 27514
(919) 966-1171

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Environmental Sciences and Engineering is a component of the School of Public Health of the University of North Carolina at Chapel Hill. The school is one of five professional schools in the university's Division of Health Sciences, and is one of nineteen such schools in the U.S. accredited by the Council on Education for Public Health. Graduate study and research in sanitary engineering were initiated in 1921. The program continually expanded and became Environmental Sciences and Engineering in 1962. In addition to Environmental Management and Protection, the department offers graduate instruction and research in four other programmatic areas: Air and Industrial Hygiene, Environmental Chemistry and Biology, Radiological Hygiene, and Water Resources Engineering.

The EMP program focuses on the education of "environmental managers", with emphases on the analysis of environmental problems and the development of operational programs. The educational content includes technical areas, as well as preparation in the concepts and methodologies of environmental management. A major program goal is to prepare professionals who can operate within the common ground shared by scientists, technologists, and decision-makers. The usual degrees offered within this specialty area are the M.S.P.H. and the Ph.D.; however, the M.S. and the M.P.H. are also available to students. The M.P.H. program is accredited by the American Public Health Association. The M.S.P.H. is primarily intended for those students who are preparing for scientific, technical, and managerial responsibilities in municipal, state and federal agencies, or in industry and consulting engineering firms. To pursue similar career objectives, M.S. candidates may place more emphasis on thesis research. Graduates of the EMP program with master's degrees, normally are offered positions which require a generalized technical background and additional skills in planning, assessment, environmental program strategies and administration. Study for the Ph.D. is intended primarily for those preparing for careers in teaching and research, although the degree is becoming increasingly applicable for professional practice.

The department places heavy emphasis on research, and is involved with over seventy separate research and grant contracts in diverse environmental fields. EMP students are provided with the opportunity to do laboratory and field research. Current research interests include applied research in microbiology and aerobiology of the hospital environment, disinfection and sterilization processes, community noise measurement and analysis, rural environmental quality assessment, and human health effects associated with environmental agents. A fully equipped microbiology laboratory is available for research, and cooperative arrangements with several institutions provide support for hospital-based studies. Also, facilities in two government research laboratories for the study of health effects are available for student research. The program has noise measuring equipment which can be used for the measurement of noise from point and general sources.

The department is involved with a number of special programs and has available a wide range of resources. Special programs are carried out in the Water Resources Research Institute, The Institute of Marine Sciences, and the Occupational Safety and Health Educational Resource Center. Faculty also participate in international programs of assistance in environmental research and education for developing countries. Some of the more outstanding facilities of the department include the Ambient Air Chamber Facility, the Wastewater Research Center, the Radiation Biophysics Exposure Facility, an aerosol lab, and limnological laboratories.

PROGRAM REQUIREMENTS

For admission into the department, all candidates must submit at least two letters of academic reference, a statement of career objectives, the aptitude portion of the GRE and transcripts from all institutions attended (the average grade point for all new EMP students in the fall of 1977 was 3.38; the average GRE score was 1164). For doctoral students, a statement of research interests is also required.

Master's students normally come from undergraduate programs with majors in biology, chemistry, or engineering. Students from any undergraduate major are expected to have had basic course work in biology, chemistry, physics, and mathematics through calculus. Increasingly, prospective students have additional preparation in economics and some courses in the social sciences. The master's program is primarily designed as a program of study leading to a professional degree (M.S.P.H. and M.P.H.) for recent undergraduates and for mid-career development.

Students holding only bachelor's degrees who desire the Ph.D. must pursue this degree through the master's degree. Students already holding master's degrees from other schools may be admitted directly or may be required to enroll for a second master's degree. Admission requires the sponsorship by a faculty member who agrees to serve as the student's program advisor. A master's degree in a similar or allied field is normally required for direct admission into the Ph.D. program.

School requirements for the M.S.P.H. include a basic biostatistics course, a basic epidemiology course, and five departmental courses, or fifteen hours, in a field consistent with the program area. M.P.H. candidates must also take basic biostatistics and epidemiolgy courses, health related courses in at least two departments other than Biostatistics, Epidemiology, and Environmental Sciences and Engineering, and three courses, or nine semester hours, in a field consistent with the program area. Programs of study for M.S. candidates are individually designed by the student in consultation with his/her faculty advisor. A minimum of thirty semester hours of credit is required for all master's degrees, and all students pursuing professional degrees must select a topic and develop an acceptable technical report and register for ENVR 392 for at least three credits in the completion of this report. M.S. candidates are required to complete and defend a formal thesis. Master's reports and theses may range from a bench laboratory study to a field-based study. They are presented at the time of the required oral comprehensive examination. The master's degree requirements may be fulfilled in eleven months, but the more usual time period is eighteen months.

There are no formal course requirements for the Ph.D.; a program of study is developed with the student's committee to provide mastery in the chosen field. In addition to the major, doctoral candidates must have a supporting program of at least fifteen hours; a formal minor may be elected. Two courses in a research skill are required, and all course work is examined at the time of a written examination. An approved dissertation must be prepared that is expected to be a significant and original contribution to knowledge. This is presented and defended at a final oral examination. Registration in ENVR 394 for at least three credit hours is required in the completion of the dissertation. Study and research for the Ph.D. degree normally takes three years beyond the master's degree.

EMP students may follow courses of study in either environmental protection or environmental management. Applicants with appropriate job experience are encouraged to select the management track, which is intended for persons who will direct the operations of environmental protection programs in government or industry. Courses are taken in the areas of environmental planning, assessment and administration, policy, law, economics and systems analysis. Students coming directly from undergraduate programs are advised to concentrate on the technical and scientific aspects of health protection and environmental control. These courses emphasize current concepts, technologies and practices, and basic preparation in program planning and management. A specialized program on the institutional environment is also available, which prepares students for administrative and technical positions in environmental control, in health care facilities and related institutions.

CURRENT FACULTY, STUDENTS, GRADUATES

Three full-time and one adjunct faculty members carry out teaching and research responsibilities within the EMP program. All faculty members hold the doctorate degree, with major research/teaching interests in a variety of areas related to environmental management and protection.

During the 1977-1978 term, twenty-one students are seeking master's degrees in the EMP program, as well as one person seeking the Ph.D. The overall enrollment represents a gradual increase over the last ten years. Ten of these students are self-supporting, one has a loan, and the remainder are supported by training grants and assistantships. The number of training grants available to students in the department has reduced substantially in recent years.

Nine persons graduated with the M.S.P.H. degree from the EMP program during the 1975-1976 term. During the following year, thirteen persons received the master's degree, the majority receiving the M.S.E.E. Of these twenty-two graduates, the employment status of nine is unknown, or they had not yet accepted positions at the time of the survey. Six accepted positions with governmental environmental/occupational health agencies, three joined consulting firms (one in Saudi Arabia), three are with hospitals or medical schools as researchers or instructors, and one is pursuing the Ph.D.

PROGRAM PROJECTIONS

The student enrollment in the department and within the specific programs is not expected to increase, as the department is currently authorized to admit only as many students as it graduates. There will be an addition of one faculty member in the EMP program, in the area of resource economics.

A major departmental programmatic change may take place within the year. Under discussion is the development of research and course offerings on the effects of contaminants on human health. As envisioned, such a development would embrace such diverse disciplines as toxicology, medicine, pharmacology, and oncology, and would tackle such subjects as the relationship of water quality to cancer incidence and the effects of air discharges on upper respiratory ailments. How this new emphasis will be incorporated into the current departmental structure is as yet to be determined. A research committee has been developed to study alternatives and to provide recommendations; money is available for several new faculty members; and efforts are underway to secure new research grants in this area.

COURSE DESCRIPTION

Required Courses:

ENVR 212 Planning and Development of Environmental Hygiene - Programs Concepts and techniques in planning, organization, and management. Program development, decision making, methods for achieving administrative ends, field supervision, criteria establishment and evaluation procedures with reference to environmental hygiene programs. (3 s.h.)

ENVR 251 Environmental Protection I - The scientific rationale and technology of the control of semi-public and private water supplies, liquid and solid waste disposal, lighting, the thermal environment and ventilation. First order reactions, the electromagnetic spectrum and fluid mechanic are applied to a series of environmental hygiene problems. (3 s.h.)

ENVR 252 Environmental Protection II - The scientific rationale and technology of the control of chemical and biological hazards in food and the quality of housing. The principles, methods, and interpretation of laboratory and field test for the evaluation of environmental contaminants. The effect of environmental stress on behavior. (3 s.h.)

Recommended Courses:

ENVR 143 Applied Physiology and Toxicology - Physiologic response of the various organs and organ systems of the body to the physical and chemical stresses of the industrial environment. The method of industrial toxicology and the toxicological basis for the Threshold Limit Values. Concentration-Time equivalence, routes of entry, synergism are investigated in the laboratory. (3 s.h.)

ENVR 171 Water Quality Evaluation and Control - Characteristics of water as a resource. Water uses, trends. Water quality concepts, measurements, criteria, problems, pollutants. Water supply and wastewater treatment and disposal systems. Regulation of water quality standards. (3 s.h.)

ENVR 211 Environmental Management - An analysis of decision-making for environmental protection programs including policy development, program implementation and management approaches. Case studies of specific environmental protection problems emphasizing public policy and actions, organizational structure and institutional arrangements. (3 s.h.)

ENVR 215 Environmental Issues and Assessment - Concepts and methodologies for assessing the environmental, ecological and social consequences of technological development. The preparation of environmental impact statements and case studies of specific projects. (2 s.h.)

ENVR 217 Systems Analysis in Environmental Planning - Systems approach and scientific method. Various approaches to system design. Mathematical models. Production, benefit, loss and cost functions. Constrained optimization. Marginal analysis, linear programming. Application of techniques to systems for the management of environmental quality. (3 s.h.)

ENVR 283 Natural Resource Law and Policy - An examination of the law of resource use and development, its administration and underlying policies. Particular attention to water rights law, regulatory law, and natural resource administration. Regulatory aspects of pollution control programs. (3 s.h.)

Other Selected Electives:

ENVR 138 Environmental Virology - Ecological, environmental health and fundamental aspects of virology, with special emphasis on viruses in air, water, and food. (4 s.h.)

ENVR 141 Elements of Air Hygiene - Health aspects of the air from the standpoint of community air pollution. The chemical and physical behavior and the biological effects of air contaminants. Means of controlling air pollution. (2 s.h.)

ENVR 142 Elements of Industrial Hygiene - Problems and control of exposure to occupational diseases and industrial accident hazards, the organizations and function of industrial and governmental services dealing with these problems, the industrial aspects of communicable and non-communicable diseases, the procedures of workmen's compensation plans, and the integration of occupational health services with local health department activities. (3 s.h.)

ENVR 154 Management of the Institutional Environment - The study of the particular environment of hospitals, nursing homes, and related institutions. The application of biological and chemical methods to the identification of problems; the epidemiology and management of environmental factors influencing health in the institutional setting. (3 s.h.)

ENVR 161 Elements of Radiological Hygiene - The physics of ionizing radiations, their interactions with matter, biological effects and principles of radiation protection. (2 s.h.)

ENVR 255 Solid Wastes Management - The changing characteristics of solid wastes, relations to health, resources and land use, costs of collection and transportation. Current and experimental disposal processes and the interactions among water pollutants, air pollutants and solid wastes. (2 s.h.)

ENVR 282 Public Investment Theory and Techniques - A study of new methods of economic, engineering, and governmental analysis in public investment planning. Techniques include those for converting broad community objectives into specific criteria to design public projects, with special emphasis on water resources. (3 s.h.)

ENVR 313 Environmental Health Problems in Developing Countries - Selected problems relating to achievement of social, economic, and technological benefits in developing countries through improvement of the environment. Seminar topics: technical processes and innovation, institutions, modification of values and attitudes, planning and administration (general applications and specific case studies of environmental change). (1 s.h.)

Students are also encouraged to consider:

Political Science 101 - Public Administration

Political Science 213 - Public Administration and Policy Making

Planning 225 - Dimensions of Land Use Planning and Management

Planning 241 - Environmental Planning

INSTITUTION: UNIVERSITY OF OKLAHOMA

PROGRAM: Environmental Science

DEPARTMENT: Civil Engineering and Environmental Science

DEGREE: Bachelor of Science (B.S.), Master of Environmental Science (M.E.S.), and Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Larry W. Canter
Director, Civil Engineering and
Environmental Science
University of Oklahoma
202 West Boyd Street
Norman, Oklahoma 73019
(405) 325-5913

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental science and engineering programs, at the University of Oklahoma in Norman, were established in 1974. Although the major programs are conducted at the graduate level, OU also offers the baccalaureate degree. Undergraduate students receive training in a variety of areas, thus preparing the graduates for occupations which require the skills of the generalist, or for entrance to advanced degree programs. Specialization is emphasized at the graduate level through instruction and research in areas of environmental concern such as air and water resources, environmental analysis and assessment, solid waste management and design and management of urban systems. Industrial hygiene and radiological health complete the areas which are addressed at the graduate level. All programs place strong emphasis on the sciences and mathematics.

Students of the OU environmental science and engineering programs are considered to be highly employable, and government and industry actively recruit these graduates at all levels. Students may delay the pursuit of highed educational degrees, in response to employer overatures. Historically, a preponderance of these graduates have accepted employment in occupations such as: environmental engineer; radiation physicist; hydrographer; water pollution control biologist; water resources engineer; safety engineer; environmental monitor specialist; and pollution control specialist. Graduates of the advanced degree programs were in a position to demand the higher salaries, however.

The environmental science and engineering programs are administered through the College of Engineering which is located in a new six-story building on the edge of the Norman campus. Well-equipped laboratories offer faculty and students the most up-to-date facilities for research and instruction. The laboratories include: structures, soils, models, sanitary, radioisotope and hydraulics. A major research unit of the College of Engineering, is the Bureau of Water and Environmental Research which affords support and cooperation to the environmental science and engineering programs.

One of the most innovative and promising facets of the Oklahoma system of higher education is the Oklahoma Higher Education Televised Instruction System which is referred to as the Talkback Television System. Almost all of the state's major institutions of higher education participate in this program. Students are required to apply and to be admitted in good standing to an institution which is a member of the system. By judicious utilization of the Talkback Television System, graduate students may earn as much as 50% of their degree program from other institutions. The University of Oklahoma is a major participant in this effort. Students in the broadcasting studios and in the receiving centers quickly become accustomed to this innovative educational endeavor. Faculty and students are equally enthusiastic about the system. The capacity for transmitting higher education from the academic centers to remotely located students is unlimited.

PROGRAM REQUIREMENTS

Admission to the environmental science and engineering programs is predicated upon acceptance by the university and by the College of Engineering pursuant to satisfaction of entrance requirements. Students are recruited at the secondary level by the usual university procedures. There is no recuritment program for graduate students, as the university and the college enjoy a reputation of excellence. Competitive applicants for graduate study, therefore, are evaluated by a committee, in accordance with the particular admission criteria.

The Bachelor of Science degree is awarded upon the successful completion of a minimum of 127 semester hours of course work. Completion of the lower division, 65 semester hours curriculum in environmental science includes: Engr. 1112, 2722; and CE 2102, 2111. The upper division curriculum includes: ES 4114, 4313, 4323, 4980/4980; Phys. 2524; Pol. Sci. 4313; a minimum of nine semester hours of approved science electives; a minimum of 12 semester hours of humanistic social studies; and, a minimum of 18 semester hours of approved technical electives.

Requirements for the Master of Environmental Science include at least 32 semester hours of course work, or 26 semester hours and a thesis. At least 16 semester hours must be in the departmental courses at the 4000-level or above. The masters level study is individually tailored to meet the specific needs of the student.

In general, the Doctor of Philosophy degree requires at least 60 semester hours of post-graduate course work and 30 semester hours of dissertation. Although the doctoral programs are individualized according to the specific interests of the student, at least 30 semester hours of science and mathematics, and a research project are required.

CURRENT FACULTY, STUDENTS, GRADUATES

The current faculty responsible for the environmental science and engineering programs, totals nine full-time personnel. Seven members

PROGRAM PROJECTIONS

The OU environmental science and engineering programs have stabilized and significant changes in student and/or faculty composition is not anticipated. Program changes involving course requirements and additional curricula packages are not planned for the near future.

COURSE DESCRIPTION

Undergraduate courses:

ES 4114 Environmental Measurements - Basic analytical techniques of water analysis and treatment; organic and inorganic constituents of water and dewage; chemical unit processes in water treatment. (4 s.h.)

ES 4233 Environmental Engineering II - (Same as Civil Engineering 4233) Concepts of water and dewage treatment. Design problems.

ES 4313 Environmental Science I - Survey of various types of environments (air, water, land, urban, rural, occupational); sources, levels and effects of pollution in these environments; environmental quality criteria. (3 s.h.)

ES 4323 Environmental Science II - Environmental movements, interactions and transfers; movement of specific pollutants; environmental impact and assessments. (3 s.h.)

ES 4980 Environmental Science Senior Research - Intensive research investigation of a special project under the direction of a faculty member. (12 sh.h. max.)

Graduate courses:

ES 5013 Epidemiology and Statistical Interpretation - The statistical tools for properly evaluating endemicity, epidemicity, and control.

ES 5032 Radioisotope Techniques - (Same as Civil Engineering, Nuclear Engineering, Petroleum Engineering 5032). Fundamentals, methods of detection and exercises; radiation protection and isotope application.

ES 5041 Radioisotope Techniques Laboratory - (Same as Civil Engineering, Nuclear Engineering, Petroleum Engineering 5041). Laboratory experiments in safe handling of isotopes.

ES 5053 Radiological Health - Problems associated with radiation, radiation exposure and effects, measurement and protection, and in general treats radiation as a factor of environmental health.

ES 5063 Radiation Protection Engineering - (Same as Civil Engineering 5063). Description and analysis of radiation facilities; accelerators, X-ray, radioactive materials.

of this faculty hold the Doctor of Philosophy degree and all have accomplished research in appropriate fields. All nine are cost-centered.

Enrollment at the baccalaureate level, includes 40 full-time students, of which 77% are male and 23% are female. This total does not include freshmen.

The graduate programs have a total of 170 students currently enrolled. At the masters level there are: 32 male and 10 female part-time students; and, 39 male and 11 female part-time, Talkback-TV students. In total, at the masters level, there are 104 male (70%) and 31 female (30%) students of which 93 or 69% are part-time.

Doctoral students include: seven male and two female full-time students; and, 20 male and six female part-time students. Of the 35 total doctoral students, 27 or 78% are male, and 26 or 74% are part-time.

ENROLLMENT

	full-time				part-time				total			
	#		%		#		%		#		%	
Degree	M	F	M	F	M	F	M	F	F-T	P-T	F-T	M
B.S.	31	9	77	23	0	0	0	0	40	0	100	77
M.S.	32	10	69	31	33	10	70	30	42	93	31	70
TV	0	0	0	0	39	11	72	28				
Ph.D.	7	2	72	28	20	6	70	30	9	26	26	78
									91	119	43	77
					Total				210		100%	

M = male; F = female; F-T = full-time; P-T = part-time.

Approximately 45 total students graduate annually from the environmental science and engineering programs. At the baccalaureate level eight to ten graduate annually. The graduate programs graduate approximately 30 per annum at the master's level, and five per annum at the doctoral level.

Of those students graduating with the Bachelor of Science degree, approximately 5% continue for further education. At the graduate level, approximately 15% of the master's students pursue the advanced degree at the doctoral level. Historically, these students have chosen the OU doctoral program.

Financial aid in various forms is available to students at the University of Oklahoma. Approximately 34% of the full-time students, however, meet tuition obligations through individual means.

ES 5083 Effects of Ionizing Radiation - Chemical and biological effects of ionizing radiation, acute and long term effects of radiation exposure, basis of radiation exposure limits, treatment of radiation injury, etc.

ES 5113 Advanced Environmental Chemistry - Dilute aqueous solutions; interaction of water with rocks and minerals; models of types of interactions and reactions in natural water systems.

ES 5133 Advanced Environmental Biology - Interaction of organisms and their environment, ecosystems, trophic structures, bio-geochemical cycles, food chains, kinetics and synthesis and growth, fresh water marine and terrestrial habitats, development of models of biological systems.

ES 5223 Chemical Aspects of Sanitary Science - (Same as Civil Engineering 5223). Physical and chemical properties of pure water; kinetics and equilibria in water and sewage, basic analytical techniques; inorganic and organic constituents of water and sewage.

ES 5232 Housing, Institution, and Hospital Environmental Survey - A study in depth of the environmental health needs of the community as related to housing and institutions, particularly hospitals.

ES 5244 Water and Waste Treatment Processes and Operations - (Same as Civil Engineering 5244). Pilot studies of design criteria for water and waste treatment plants.

ES 5253 Public Health Administration and Law

ES 5273 Radiological Surveillance, Assay, and Hazard Generation - A laboratory-lecture course concerned with environmental survey and assay, including theory and operation of survey instruments, sampling procedures, data interpretation, monitoring techniques, and emergency procedures.

ES 5323 Biological Aspects of Environmental Science - Presentation of the diversity and importance of disease-producing and nuisance-causing organisms; or organisms involved in solid and liquid waste reduction; their importance in domestic and foreign public health programs.

ES 5500 Public Health Field Practice - (1-8 s.h.)

ES 5603 Environmental Science - Broadly presents the field of environmental health.

ES 5624 Food Protection, Systems and Analysis - Study of milk and food industry and sanitation requirements and enforcement problems.

ES 5653 Industrial Hygiene - Recognition, evaluation, and control of occupational health hazards.

ES 5663 Noise Environment - Principles of noise pollution, characteristics and effects on the environment; noise evaluation; industrial, ES 5663 (cont'd) - community, and transportation noise; control procedures and social and legal implications.

ES 5803 Solid Wastes Systems Planning - (Same as Civil Engineering 5803). Engineering aspects of solid waste disposal by sanitary landfills, composting, and combustion; systems planning in solid waste management; industrial solid waste management.

ES 5853 Bionics: The Design of Biosynthetic Systems - (Same as Industrial Engineering 5853). Systems theory is followed by detailed consideration of important biological functions and physical methods of achieving simulation.

ES 5883 Human Factors in Technology - (Same as Industrial Engineering 5883). Capabilities and limitations of a human operator are evaluated with regard to stresses encountered in industrial, military, and space environments.

ES 5980 Research for Master's Thesis - (1-4 s.h.)

ES 6030 Radiological Safety Programming - May be repeated with change in topic; maximum credit four hours for master's degree, eight hours for doctor's degree. Selected topics in radiological health; nuclear facility siting, electronic product, radiation dosimetry.

ES 6210 Environmental Science Special Topics - Research oriented problems dealing with current topics of special interest in environmental science. May be repeated with change in topic; maximum credit four hours for a master's candidate, six hours for a doctoral candidate. (1-6 s.h.)

ES 6260 Advanced Radiological Health Laboratory - Based on radiochemical determinations of air, food, and water samples; waste disposal; shielding. (2-6 s.h.)

ES 6323 Vector Control and Solid Waste Management - Measures for the abatement or control of arthropods, rodents, birds, and other disease vectors of public health importance. Formulation of pesticides; pesticiding equipment; refuse storage and collection and disposal standards.

ES 6604 Sanitary Design and Water Resources - (Same as Civil Engineering 6604). Water quality standards are established and adjustments required to bring various raw and wastewater to these standards are analyzed and organized treatments are designed.

ES 6613 Water Resource Systems Analyses - (Same as Civil Engineering 6613). Water resource systems are studied in relation to natural and non-engineering restraints.

ES 6971 Public Health Seminar

INSTITUTION: UNIVERSITY OF PITTSBURGH

PROGRAM: Environmental and Sanitary Engineering

DEPARTMENT: Civil Engineering

DEGREE:
Bachelor of Science (B.S.)
Master of Science (M.S.)
Ph.D. in Civil Engineering

CONTACT:
Dr. Joel I. Abrams
Chairman of Civil Engineering Department
University of Pittsburgh
Room 949 Benedum Hall of Engineering
Pittsburgh, Pennsylvania 15260
(412) 624-4141

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Civil Engineering first started granting degrees in 1846 and fields of specialization are currently offered in Sanitary Engineering, Water Resource Engineering, and Mine Environmental Engineering and Reclamation. Graduates are employed in positions involving water resources, water supply, waste disposal, air pollution and environmental sanitation. Many graduates find positions with consulting engineering firms (including sales) in research, teaching, and governmental agencies.

Work for full-time students and a complete part-time program are strong points of the Master's degree program. Water resources and environmental engineering are specialty areas in the doctoral program and active research is on-going in both of these areas.

The Environmental and Sanitary Engineering program emphasizes research and courses in the following areas:
Chemistry and biology;
Water analysis for water quality control;
Pollution and control of natural waters;
Unit processes and operations applied to the design of water and wastewater treatment plants;
Solid waste disposal;
Disposal of sludges and concentrates;
Economics;
Administration of sanitary engineering facilities; and
Basin studies and regional environmental planning.

The Department's Sanitary Engineering Laboratories have the necessary equipment and instrumentation for determining all the standard wet chemical and microbiological analyses of water and wastewater. Two walk-in incubators and all the latest equipment for the newer sophisticated instrumental techniques are included in these facilities.

PROGRAM REQUIREMENTS

Applications to the graduate program may be considered on an individual basis, but for the applicant who is a recent graduate with a degree from a school accredited by the Engineer's Council for Professional Development (EPCD), admission is granted on the basis of the undergraduate record, and usually an applicant with a B average will be granted admission.

At the undergraduate level, electives are available during the sixth, seventh, and eighth terms to enable a student to pursue an individualized program in the environmental and sanitary engineering area. The Bachelor of Science degree requires completion of 121-123 credits and the undergraduate program is noted for its flexibility in accomodating student interests in environmental and sanitary engineering.

Graduate students prepare a plan of study during their first term and assistance is provided by a faculty advisor. The Master of Science degree is offered with a thesis and a non-thesis option. The thesis option requires completion of a minimum of 24 course credits (eight courses) plus a thesis (six credit minimum). Students electing the non-thesis option are required to complete ten courses for 30 course credits (minimum) and prepare a three credit project. Graduate Preliminary Examinations are given to determine the admission of a marginal case. A Comprehensive Examination is given to all non-thesis program students and to some thesis program students. A Final Oral Examination is given to evaluate the findings of the student's M.S. thesis or project and related course work. Graduate research assistants are required to write a thesis upon recommendation of the advisor and project supervisor.

In order to complete the requirements for the Doctor of Philosophy degree, a minimum of 30 course credits (ten courses) in a major area, a minimum of 18 course credits (6 courses) in a minor area (one or two minor areas, but one outside the Civil Engineering Department), a minimum of six course credits (two courses) in Analytical Techniques, and a minimum 18 credits of dissertation are required. A Plan of Study and Proposal Conference is administered by the faculty advisor and a member of the faculty in the student's major and minor areas of interest. All Ph.D. students take a Comprehensive Examination toward the end of their course work,and the Final Oral Examination of three hours duration is administered by the Doctoral Committee.

A wide variety of financial aid packages are available to graduate students enrolled in the School of Engineering. Fellowships are offered to exceptional students as an unrestricted grant. Traineeships are offered in selected areas and there are usually restrictions on the courses which are allowed to be taken. Tuition scholarships provide for partial or full remission of tuition. Research assistantships are awarded as research contracts and teaching assistantships and teaching fellowships are awarded from department funds for assistance in laboratories, recitation sections, and for other teaching duties.

CURRENT FACULTY, STUDENTS, GRADUATES

Eight faculty members teach the environmental and sanitary engineering courses offered by the Civil Engineering Department. Approximately one-half of their time is devoted to research activities. Funding for research comes from the National Institutes of Health, the Department of Energy (ERDA), the National Science Foundation, and the American Iron and Steel Institute. A joint U.S. Environmental Protection Agency and American Iron and Steel Institute project on industrial wastes will be forthcoming to the Department. Most research work by faculty is in the areas of heavy metals (using biological treatment to remove heavy metals) and in the pollution effects resulting from energy production and conversion.

The Civil Engineering Department has 320 Bachelor of Science students (including 40 female) enrolled in the fall term, 1977 and 35 students (five female) have elected to take environmental and sanitary engineering courses as electives. About 100 students receive the B.S. degree annually.

At the graduate level, there are a total of 220 students (70% part-time) enrolled in the M.S. and Doctor of Philosophy degree programs in the Civil Engineering Department. Approximately 175 are M.S. candidates and 35 are Ph.D. candidates. Of students electing the environmental and sanitary engineering option, 60 are M.S. students (3 female) and 20 are Ph.D. students (one female). Approximately 35 M.S. degrees and three to four Ph.D.'s are annually granted by the department; of these diplomas conferred, about 15 M.S. and 2 Ph.D. degrees are to students participating in the environmental and sanitary engineering area.

About forty percent of the B.S. students and fifteen percent of the M.S. students continue on for advanced degrees. Most students choose to continue their studies at the University of Pittsburgh. There are many part-time students enrolled in the M.S. degree program mainly because of the availability of jobs in the area. Virtually all graduates find employment directly in their field and it is estimated that 80 percent find jobs in the private sector and 20 percent find positions in government. Most finding private sector jobs are found in consulting engineering firms.

PROGRAM PROJECTIONS

It is not anticipated that the program will significantly increase in the foreseeable future as the Civil Engineering Department has completed a growth phase during the past two years. The program is at a plateau phase but greater emphasis may be given to sanitary engineering, laboratory experimental work, mathematical modelling, hydraulic systems, urban hydrology, and urban pollution in subsequent years. It is expected that only one additional faculty member with expertise in mathematical modelling of lakes will be recruited in the next few years.

COURSE DESCRIPTION (SELECTED)

217 Economics of Projects in Environmental and Civil Engineering - Economic theory applied to use and control of project management and evaluation. Case studies from water resource field. (3 s.h.)

218 Planning, Administration, Management and Legal Aspects of Projects in Environmental and Civil Engineering - Administrative concepts of water pollution control and other Civil Engineering Projects at all levels of government. Government planning and construction aid programs for environmental control. (3 s.h.)

240 Hydraulic Engineering - Review of fundamental hydraulics. Hydraulics of flows in closed and open conduits. Hydraulic structures. (3 s.h.)

242 Hydraulic Transport of Solids - Hydraulic transport of solids in pipelines and open channels. Hydraulics of multi-phase flows. Applications in design of slurry pipelines and open channels and sediment transport in natural waters. (3 s.h.)

244 Surface Water Hydrology - Hydrologic cycle as a deterministic and stochastic system; rainfall-runoff relations; hydrograph analysis, frequency analysis and extreme value theory; design applications. (3 s.h.)

245 Groundwater Hydrology - Mechanics of flow through porous media. Darcy's law, potential flow theory, steady and unsteady flow to wells, practical aspects of well design, numerical methods, leaky aquifer theory. (3 s.h.)

250 Sanitary Engineering Biology - The fundamentals of biology and biochemistry are discussed, particularly as applied to natural waters and wastewater treatment systems. (4 s.h.)

252 Water and Wastewater Analysis - Principles and applications of quantitative chemical analyses of water and wastewater. (4 s.h.)

254 Water Pollution of Natural Waters - Natural history of water bodies, characteristics of natural water, ecological principles, sources and effects of pollutants, assimilative capacity, oxygen balance, eutrophication, acid mine drainage, thermal pollution, stream standards, water quality monitoring, basin planning. (3 s.h.)

255 Water and Waste Treatment Plant Design - Step-by-step development of a complete plant design for a hypothetical city. Design will be rational and empirical, not theoretical. Process design, equipment selection, economic evaluation, and plant layout will be emphasized. (3 s.h.)

259 Current Topics in Environmental Resources - Group discussion of selected readings and investigation into events of current environmental interest. (3 s.h.)

265 Advanced Environmental Systems Laboratory - Functional design, simulation, and evaluation of elements of environmental systems. (Var. cr.)

267 Advanced Social and Environmental Systems Analysis - Time series analysis, estimation of recursive systems, the identification problem, estimation of simultaneous equation systems. Environmental application. (3 s.h.)

340 Selected Problems in Water Resources - Applications of theories and principles to various practical problems and current topics in water resources. (3 s.h.)

351 Unit Operations of Water Treatment - Theory of several unit processes and operations as applied to water treatment. (3 s.h.)

356 Solid Waste Disposal - Theory, design and operation of systems for the collection and disposal of solid wastes. Course includes study of composition of municipal garbage and refuse and available collection methods. (3 s.h.)

365 Environmental Assessment - Methodology of technology assessment; environmental impact analysis, environmental indicators and the strategic environmental analyses system; case studies; the 1972-74 SST review. (3 s.h.)

390-391 Sanitary and Environmental Engineering Seminar - Current sanitary and environmental engineering subjects. (1 s.h.)

INSTITUTION: UNIVERSITY OF PITTSBURGH

PROGRAM: Industrial Hygiene and Air Engineering

DEPARTMENT: Industrial Environmental Health Sciences

DEGREE: Master of Science in Hygiene
Master of Public Health

CONTACT: Dr. Edward McGovern
Research Assistant Professor of Industrial Hygiene
Graduate School of Public Health
University of Pittsburgh
Pittsburgh, Pennsylvania 15260
(412) 624-3043

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Industrial Environmental Health Sciences offers specialized academic training in the area of industrial hygiene. The Industrial Hygiene and Air Engineering specialty program was first initiated by the Graduate School of Public Health in 1965 and is a one-year program of study leading to a master's degree for physical or geological scientists or engineers. Graduate students may extend this program to a doctoral degree with emphasis in a selected area of industrial hygiene or air engineering, e.g. industrial hygiene engineering, analytical methods, aerosol physics. Doctoral candidates have adequate flexibility in their program to be able to select courses offered in the School of Engineering, departments in the natural sciences or School of Medicine.

The Graduate School of Public Health has a wide variety of modern research laboratories which include an anechoic chamber and a whole body counter. Further research opportunities exist in the Pittsburgh area in county and state health departments, local industries, and local health and welfare agencies.

PROGRAM REQUIREMENTS

In order to be admitted to the Industrial Hygiene and Air Resources program, applicants must possess a B.S. or A.B. degree in arts, science, engineering, or nursing or an M.D., D.D.S., D.V.M., from an approved school.

The program is offered over three trimesters (September through July) and consists of a total of 36 credits for the master's degrees. Master's students are also required to take six to eight credits of electives (e.g. acoustics, radiation health, water quality management, toxicology, air resources) and write a satisfactory master's essay.

The Industrial Hygiene program during the 1977-1978 academic year offered an internship program for students with no previous work experience. They spend two trimesters full-time in study at the University and two trimesters (6 months) working in a selected industrial setting. Students have been placed on the staffs of local county and state health departments.

The Graduate School of Public Health annually receives a limited amount of funding for general purpose traineeships. Industrial hygiene traineeships are available which provide $1,000 each toward each student's tuition expenses. A variety of support is provided to industrial hygiene students during the 1977-1978 academic year. Of 14 M.Sc. students: eight received support from the National Institute for Occupational Safety and Health; three from the U.S. Environmental Protection Agency; and one each received support from the World Health Organization, the Brazilian Government and the Occupational Safety and Health Administration. Three part-time M.Sc. students were enrolled in 1977-78 and all three were self-supported. Of four doctoral candidates (Ph.D.), one received support from the National Institute for Occupational Safety and Health; one from the MPC Corporation; one from the Thailand Government;and one student had a Graduate School of Public Health fellowship. In sum, nine students were supported by NIOSH (43%) three from the U.S. EPA (14%); two from foreign governments (10%); three were self supported (14%); and one each received support (5%) from the World Health Organization, OSHA, the MPC Corporation and the Graduate School of Public Health.

CURRENT FACULTY, STUDENTS, GRADUATES

Six full-time faculty members teach the program's curriculum in industrial hygiene and air engineering. The program's faculty are involved with a variety of outside sponsored research which includes:

EPA - Ion Chromatography of Aromatic Amines - 9/15/77 - 9/14/79 - $105,

MPC - Preliminary Investigation of Submicron Aerosols in Allegheny Coun
10/1/77 - 9/30/78 - $59,515

DeNardo & MacFarland Weather Service - Precipitation Acidity in Rural Areas - 7-1-75 - 99-99-99 - $11,395

Thermal Insulation Manufacturers Association - Determination of Airborne Concentration in Ceramic Fiber Manufacturing Facilities - 5-1-76 - 6-30-99 - $50,499

Owens Corning Mfg. Co. - Determination of Fiber Erosion from Glass Fiber Filters - 2-1-77 - 6-30-99 - $65,527

Thermal Insulation Manufacturers Association - Determination of Airborne Fiber Concentration Due to Utilization of Man Made River Products - 5-1-76 - 6-30-99 - $56,559

There are currently a total of twenty-eight students enrolled in the program and four are female. A total of 15 students (2 female) are enrolled full-time and 10 (2 female) are enrolled on a part-time basis. There are 15 full-time and 10 part-time master's students and three doctoral students currently enrolled (Spring, 1978).

Approximately 15 students receive degrees from the program on an annual basis and the program has been expanding each year to a limit of 16. Very few students continue on for further degrees offered by other educational institutions but some have gone on to other doctoral programs in the University of Pittsburgh.

Virtually all graduates obtain employment in their field and it is estimated that 60 percent find private sector jobs and 40 percent find government positions. The American Industrial Hygiene Association Employment Service has greatly assisted graduates in finding jobs. Recent graduates have found administrative positions as corporate industrial hygienists, in university teaching, and evaluation and control positions in both government and private industry as industrial hygienists.

The program maintains an updated alumni list of graduates and according to the most recent follow-up study conducted of 16 1977 graduates: nine students (63%) found private sector jobs, one with a consulting firm (6%); one found employment with the National Institute for Occupational Safety and Health (government - 6%); one student was self-employed (6%) one was a doctoral candidate in the Graduate School of Public Health (6%); and one student was still interviewing for an industrial hygiene position (6%).

PROGRAM PROJECTIONS

The Industrial Hygiene and Air Resources program is expected to increase to a maximum of 25 students per year over the next few years. Program officials feel that environmental programs will become stronger in industrial hygiene and weaker in both air and water pollution control and abatement. The Graduate School of Public Health needs to expand particularly in the areas of physiology and occupational medicine. Because of an increased demand for qualified industrial hygienists by the job market, one to two additional industrial hygienists are expected to be recruited for the program's faculty within the next two to three years.

COURSE DESCRIPTION

(the following is a partial listing of courses)

IEHS 201 Introduction to Occupational Health The physical and chemical properties and the methods of measurement of industrial environmental hazards are discussed. The course introduces students to the basic concepts of thermodynamics and chemical kinetics and deals with the properties and measurement of suspended particles, gases, toxic materials, heat, noise, ionizing and non-ionizing radiation. 4 cr.

IEHS 203 Industrial Medicine This is a survey course of the clinical and subclinical changes in the individual resulting from the failure of adaptive mechanisms under the stress of unusual environmental demands that may be associated with industrial employment. (1cr.)

IEHS 221 Special Studies in Industrial Environmental Health Sciences Properly qualified students may undertake research for the master's essay requirement with the approval and under the guidance of a member of the staff. (Cr. to be arranged.)

IEHS 225 Seminar in Industrial Environmental Health Sciences Current developments in research areas in industrail environmental health are represented by investigators active in the fields under discussion.

IEHS 261 Analysis of Airborne Contaminants I The laboratory course presents the physical methods of the evaluation of working conditions. Measurement of flow, sampler calibration, dust sampling and analysis, gravimetry, microscopy and respirabel dust sampling are included.

IEHS 262 Analysis of Airborne Contaminants II The laboratory course presents the methods of evaluation of physical stresses in working environments. Measurement of noise, heat, radiation are included. (1 cr

IEHS 264 Properties and Mechanics of Aerosols Static and dynamic properties of aerosols are studies. The topics covered include: rectilinear and curvilinear motion of aerosols, diffusion, impaction, coagulation, behavior in thermal, electormagnetic and electrostatic fields, sampling and estimation methods. (3 cr.)

IEHS 267 Industrial Safety Introduces the student in industrial hygiene to the occupational safety procedures required by the Occupational Safety and Health Act of 1970. (2 cr)

IEHS 269 Principles of Air Resources Introduces the student to the broad field of air pollution. The first half of the course deals with sources, economics, controls of air pollution and micrometeorology. The second half is devoted to atmospheric chemistry. (3 cr.)

IEHS 271 Ergonomics and Work Physiology The course deals with human capabilities and limitations in relation to the intrinsic stresses of muscular and nervous activity and the extrinsic stresses of the environment in which work is performed.(2 cr.)

IEHS 310 Research and Dissertation for the Doctoral Degree This includes doctoral study under the various programs within the Department of Industrial Environmental Health Sciences.(Variable cr.)

INSTITUTION: UNIVERSITY OF TENNESSEE

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Environmental Engineering (M.S.E.E.)
Master of Engineering in Environmental Engineering (M.E.E.E.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. W.L. Grecco
Department of Civil Engineering
University of Tennessee
Knoxville, Tennessee 37916
(615) 974-2503

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering began as an option in the Department of Civil Engineering in 1966. The Master of Science in Environmental Engineering is designed for students whose undergraduate background is other than engineering. The Master of Engineering is accredited by the Engineers' Council for Professional Development and therefore, requires students enrolled in this program to have undergraduate degrees in engineering. The Ph.D. is offered through civil engineering, and doctoral students may elect a major in environmental engineering.

This program conducts a large number of research activities with outside funding amounting to $846,300. The largest single contributor has been the Department of Energy (formerly ERDA) for a study entitled Environmental Aspects of Coal Production in the Appalachian Region. The U.S. Air Force is providing support for studies regarding stormwater runoff.

A substantial amount of specialized research equipment exists for students' use. For water quality analysis, an atomic absorption spectrophotometer, gas and liquid chromatographs, a programmable data analyzer, a scanning ultra-violet spectrophometer, a total carbon analyzer, selective ion electrode meters, and additional turbidmeters, spectrophotometer, fluorometers, pH meters. For air quality analysis, there are suspended particulate samplers, dustfall collectors, an MRI integrating nephelometer for visibility monitoring, a pulsed infrared laser light scattering single particle counter, an ambient particle counter, a gas analyzer for source monitoring of SO_2 and NO_x, specialized unit operations equipment, as well as other sensitive instrumentation.

A large number of specialized instruments is available for laboratory experimentation in water and wastewater treatment research. The library services on the Knoxville campuses are supplied by three major libraries, including a science and engineering library. Combined, they contain in excess of one and one-quarter million volumes.

Graduates of the programs in environmental engineering are qualified for employment as consultants, urban planners, hydrologists, systems analysts, construction managers, county planners, researchers, environmental and civil engineers, and environmental chemists.

PROGRAM REQUIREMENTS

For admission to the M.S.E.E. program, one must have graduated from a recognized undergraduate curriculum. It may be necessary for some articulation work to be done in preparation for certain of the technical courses. The graduate progam leading to the M.E.E.E. degree is available to students who have undergraduate degrees from E.C.P.D. accredited engineering programs. No admissions examinations are required.

All graduate students in environmental engineering must satisfy a primary core curriculum of fifteen quarter hours which consists of: ENVR 4030 or 4530 - Environmental Chemistry, ENVR 5230 or 5301 - Hydrology, ENVR 5561 (or 5501, 5502 or 5513) - Water Pollution Control, ENVR 5600 - Solid Wastes, ENVR 5710 - Air Pollution Control, ENVR 5590 - Seminar. Students must then select a secondary core of concentration from the following five topic areas: water pollution control, water resources, air quality and/or pollution control, environmental science, or environmental management.

The Water Pollution Control core requires the following courses: ENVR 4530 - Sanitary Engineering Laboratory, ENVR 5593 - Advanced Sanitary Engineering Laboratory, ENVR 5501 - Water and Wastewater Treatment Theory, ENVR 5513 - Advanced Water and Waste Treatment Systems, and ENVR 5551 - Water Quality Mangement. The Water Resources core requires ENVR 5230 - Surface Water Transport, ENVR 5301 Stormwater Modelling, ENVR 5310 - Groundwater Transport, and ENVR 5232 - Sediment Transportation.

Air Quality and Pollution Control requires a secondary core of nine quarter hours which may be selected from: ENVR 5501 - Water and Wastewater Treatment Theory I, ENVR 5502 - Water and Wastewater Treatment Theory II, ENVR 5513 - Advanced Water and Wastewater Systems, ENVR 5720 - Air Pollution Particle Collection Theory, and Air pollution Control Device Design. The program in Air Quality and Pollution Management requires the following: ENVR 5720 - Air Pollution Particle Collection Theory, ENVR 5730 - Air Pollution Control Device Design, and ENVR 5700 - Planning and Air Pollution Management.

The program in Environmental Science requires: ENVR 4530 - Sanitary Engineering Laboratory, ENVR 5593 - Advanced Sanitary Engineering Laboratory, ENVR 5501 - Water and Wastewater Treatment Theory I or 5502 - Water and Wastewater Treatment Theory II or Advanced Water and Wastewater Systems, and ENVR 5530 - Natural System Behavior.

In Environmental Management, students may opt to specialize in solid waste or in water. Solid waste specialty courses include: ENVR 5310 - Groundwater Transport, ENVR 5610 - Solid Waste Collection, and ENVR 5400 - Environmental Systems Engineering. The water option calls for ENVR 4530 - Sanitary Engineering Laboratory, ENVR 5551 - Water Quality Management or 5301 - Stormwater Modelling I, and ENVR 5400 - Environmental Systems Management.

Students have the option of writing a thesis or not. Should one prefer to write a thesis, the student must present forty-five quarter hours of approved graduate courses. The major shall include a minimum of nine credits of thesis and eighteen of environmental engineering coursework. Those individuals who prefer to pursue the non-thesis option must present a minimum of forty-eight quarter hours of graduate courses. The major must include a minimum of twenty-seven quarter credits in environmental engineering coursework and a three hour special project.

The graduate program leading to the degree of Doctor of Philosophy is offered through the Department of Civil Engineering. Major fields of study include structural engineering, transportation engineering, and environmental engineering. For the Ph.D. degree, one must complete a minimum of one hundred and eight credits beyond the baccalaureate degree, inclusive of credit earned toward a master's thesis. Of this, a minimum of thirty-six credits are applied to doctoral research and dissertation. At least thirty-six credits must be taken in civil or environmental engineering. Approximately thirty-six credits must be in supporting, related scientific and engineering fields. These usually include such disciplines as mechanics, chemistry, mathematics, microbiology, physics, and other engineering fields. To insure scientific literacy, a student may be required to know/learn one foregin language if it is considered crucial to one's research efforts. After completion of half of the coursework, each student must pass a preliminary examination. After completion of the dissertation and prior to graduation, candidates must pass a final examination administered by a faculty committee.

CURRENT FACULTY, STUDENTS, GRADUATES

Seven persons have full-time responsibility to environmental engineering. Their efforts are divided to permit approximately two-thirds of their effort to go to teaching, and the remaining one-third is devoted to research.

There are thirty-two people enrolled in both master's programs full-time and twenty-one part-time. Nearly all of these students are receiving financial assistance in the form of teaching and research assistantships. Approximately sixty percent of the students are Tennessee residents. Four of the doctoral students are pursuing environmental engineering majors.

During the academic year 1976-1977, three Ph.D. degrees and sixteen master's degrees were awarded. A follow-up study of twenty-nine recent graduates show that twelve were employed in various government agencies, one is employed in a foreign government, three are pursuing Ph.D.'s, two are teaching, five are with consulting firms, ans six with private industry.

PROGRAM PROJECTIONS

Environmental engineering is a program in the midst of tremendous growth. It is hoped that in two years a mining option with an emphasis on reclamation will be approved. This program will lead to a Bachelor of Science in Civil Engineering. In 1980-1985 it is anticipated that a Bachelor of Science in Environmental Engineering will expand the engineering offerings. In the long range plans is a B.S. in county engineering.

Two new programs have been approved at the graduate level. A Master's in Civil Engineering in Construction Management and a joint degree program in Transportation/Urban Planning are in the immediate departmental planning stage.

COURSE DESCRIPTION (SELECTED)

ENVR 5150 Water and Urban Welfare - Evaluation of social, environmental and economic impact on planning and management of urban water systems. Procedures for analyzing multi-objective policy alternatives with selected case studies. (3 q.h.)

ENVR 5210 Advanced Water Resources Engineering - Complex problems encountered in water resources engineering. Analysis of problems preliminary to design of complex water resources structures. (3 q.h.)

ENVR 5232 Sediment Transportation - Sediment properties and their measurements; bed loads and suspended load movement; erosion, scour, transportation and deposition of sediments by flowing water; silting of reservoirs and related topics. (3 q.h.)

ENVR 5234 Flood Damage Reduction - Survey of national, regional, and local flood problems; hydrologic design criteria, traditional flood control measures; and other flood damage reduction elements; interdisciplinary approach in floodplain management. (3 q.h.)

ENVR 5263 Remote Sensing Data Analysis and Interpretation - Manual and automatic methods of data analysis and interpretation; use of automatic data processing equipment. (3 q.h.)

ENVR 5302 Stormwater Modeling II - Continuous streamflow records are interpreted using methods of stochastic hydrology. Hydrologic design of water resources systems using streamflow simulation techniques. (3 q.h.)

ENVR 5310 Groundwater Transport Processes - Dynamics of flow in porous media with emphasis on physical processes important in subsurface hydrology. Hydrodynamic dispersion, anisotrophy, layered soils, and unsaturated flow phenomena. Analytical solutions of flow equations. Dupuit approximation, analog and numerical methods, Hele-Shaw, and graphical solutions. (3 q.h.)

ENVR 5502 Water and Wastewater Treatment Theory II - Theory of physical, chemical, and biological processes employed in sanitary engineering. (3 q.h.)

ENVR 5513 Advanced Water and Waste Treatment Systems - Theory, operation, and use of advanced water and waste treatment systems. Emphasis on systems used for wastewater reclamation. (3 q.h.)

ENVR 5530 Environmental Engineering and Natural System Behavior - Relationship between environmental engineering and natural system behavior; focus on eutrophication and the limiting nutrient concept in relation to research and its translation into law and practice. (3 q.h.)

ENVR 5551 Water Quality Management - Water quality control objectives, methods, and philosophies; water quality criteria; regulatory standards; economic considerations. (3 q.h.)

ENVR 5561 Aquatic Environment Pollution - A study of effects resulting from agricultural, municipal, and industrial pollution upon physical, chemical, and biological characteristics of natural waters. (3 q.h.)

ENVR 5582 Microbiology for Sanitary Engineers - A study of microorganisms and microbiological processess which are significant in sanitary engineering, including basic microbiology, detection and identification, enzymes, metabolic reactions, energy transfer, synthesis and growth; aerobic and anaerobic biological treatment processes. (3 q.h.)

ENVR 5593 Advanced Sanitary Engineering Laboratory - Advanced laboratory techniques used in analysis of water and wastewater. Application of modern instrumental procedures for physical, chemical, and biological analysis. (3 q.h.)

ENVR 5600 Solid Wastes - Magnitude and characteristics of the solid waste problem; methods of collection and disposal, including sanitary landfill, incineration, composting, proposed new technologies, and recycling. (3 q.h.)

ENVR 5620 Solid Waste Collection Systems - Analysis and designs of collection systems, methods of collection, crew size, routing of vehicles, efficiency of collection systems, and management planning. (3 q.h.)

ENVR 5700 Planning and Air Pollution Control - Relationship between air pollution, area development, and urban growth. Social, economic, and political processes involved in air pollution control. (3 q.h.)

ENVR 5710 Air Pollution Control Engineering - Emission control systems for industrial and power generating processes, stack sampling methods, air monitoring, dispersion of pollutants. (3 q.h.)

ENVR 5725 Air Quality Modeling and Impact - Development of techniques to assess the air quality impact of major transportation projects and industrial air pollution sources. Application of atmospheric dispersion models and evaluation of meteorological and air quality data. (3 q.h.)

ENVR 5730 Air Pollution Control Device Design - Design and evaluation of systems used to control the emission of gaseous and particle air pollutants. Comprehensive design of specific devices and systems. (3 q.h.)

ENVR 5735 Industrial Source Sampling - Review and application of sampling methods for gaseous and particulate air pollutant emissions from industrial processes. (3 q.h.)

ENVR 5760 Diffusion in the Atmosphere - Movement and dilution of natural or man-made material released into the atmosphere. Basic theory is developed and observations reviewed. Specific topics include the rise of bouyant plumes, the relation between Eulerian and Lagrangian spectra, the differences between instantaneous and continuous sources, diffusion in a zone of wind shear and diffusion from urban area sources. (3 q.h.)

ENVR 6500 Industrial Waste Treatability and Process Control - Sources and characteristics of industrial wastes; treatment alternatives related to ultimate disposal, treatability and process control studies of physical, chemical, and biological processess using laboratory bench-scale treatment units. (6 q.h.)

INSTITUTION: UNIVERSITY OF TOLEDO

PROGRAM: Environmental Engineering, Engineering Science

DEPARTMENT: Chemical Engineering, Civil Engineering

DEGREE: Bachelor of Science in Chemical Engineering
Bachelor of Science in Civil Engineering
Master of Science in Chemical Engineering
Master of Science in Civil Engineering
Master of Science in Engineering Science

CONTACT:

Dr. Roger J. McNichols, Associate Dean
College of Engineering
University of Toledo
2801 W. Bancroft Street
Toledo, Ohio 43606
(419) 537-2405

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The University of Toledo offers undergraduate and graduate degrees within its College of Engineering that recognize the need for professionals in environmentally related fields. Students may pursue baccalaureate degrees in Chemical Engineering with an emphasis in Environmental Engineering Pollution Control or in Civil Engineering with a technical elective concentration in Environmental Engineering. The former degree choice enables students to select technical electives "in air pollution, industrial waste treatment, biochemical engineering" and other areas. The latter option centers technical electives on "the design, construction and management of facilities for public water supply and sewage treatment" as well as "control of water and air pollution, water resources management and solid waste disposal."

According to the College of Engineering informational brochure, "The purpose of the master's degree programs is to provide opportunity for advanced study in the various areas of engineering of current importance. The programs feature sufficient flexibility that a student can either probe further into a particular area of specialization, broaden the educational experience into additional areas of that field of engineering, or synthesize an integrated program of interdepartmental studies." To actualize that purpose, graduate students at the master's degree level may choose from a number of program offerings including several with environmental orientations. In the Chemical Engineering department, graduate training is available in waste disposal and pollution control. Masters degree candidates in Civil Engineering may study environmental engineering systems of domestic and industrial water supply, and waste disposal and recirculation. An interdepartmental program within the College of Engineering--Engineering Science--typically emphasizes environmental pollution and its control.

Facilities at the University of Toledo are extensive. The school maintains well-equipped laboratories for teaching and research in biochemical engineering, biological wastewater treatment, analytical methods for examining water and wastewater, air pollution, environmental chemistry, and environmental biology. Library and computer facilities lend strength to the curriculum and research conducted in the College of Engineering. An Environmental Protection Agency Training Grant, in existence since 1965, provides the major support for the graduate training programs in air and water pollution control.

The Civil Engineering Department conducts periodic workshops for local industry (e.g., Owens Corning Fiberglas) on relevant environmental topics. Though not required, the Chemical Engineering Department places a sizable fraction (1/3-1/2) of its students in an industrial setting for their thesis research. These students receive partial support through university fellowships and sometimes additional support from the industry. The university provides research supervision through the student's major professor and the industry supplies the project, partial supervision, and out-of-pocket costs for the research.

PROGRAM REQUIREMENTS

Entrance to the baccalaureate degree programs in the College of Engineering requires a high school diploma or equivalent and a minimum of 12 units at the secondary level (4 in mathematics, 1 in chemistry, 4 in English, and 3 in humanistic-social electives). Physics, biology, and two years of a foreign language are recommended. Applicants for the master of science degree programs must hold an undergraduate degree in an appropriate field (e.g., Civil Engineering candidates must have a B.S. in Civil Engineering as prerequisite). The Engineering Science students must have a B.S. in Engineering, Chemistry, or Biology, and a minimum of two years of college calculus ending with differential equations.

The B.S. degrees require 200 quarter hours for graduation. There is a set of core courses common to all engineering degrees (25 mathematics hours, 25 basic science hours, 25 humanities and social sciences, 50 engineering science hours, 25 engineering design hours). Elective courses permit the student to "specialize along lines of personal and professional interest."

At the master's level, students must complete 45 quarter hours of coursework. A thesis project, up to 9 hours credit, is normally required but may be replaced with coursework in some programs or in the case of Civil Engineering and Engineering Science, with an informal research project. The master's degree in Engineering Science mandates completion of courses in unit operations of industrial waste treatment, advanced waste treatment, and bio-engineering.

CURRENT FACULTY, STUDENTS, GRADUATES

There are three full-time faculty in Chemical Engineering and three full-time faculty in Civil Engineering involved in these environmental programs. Student enrollment currently and the average number of graduates for the various degrees with emphasis in environmental areas are:

Degree	Student Enrollment Full-Time	Student Enrollment Part-Time	Average Number of Graduates
B.S. (Chemical Engineering)	1	0	NA
B.S. (Civil Engineering)	18	0	NA
M.S. (Chemical Engineering)	2	3	2
M.S. (Civil Engineering)	1	7	2
M.S. (Engineering Science)	2	11	2

A high percentage of these program graduates take jobs in industry with substantial percentages employed in government and consulting.

Undergraduates are eligible for some scholarships and the general financial aid programs available to all students. Almost all graduate students in the College of Engineering receive some financial support. Graduate assistantships provide student employment and experience in engineering education. The U.S. Environmental Protection Agency Training Grant supports three students a year, and there is some industrial support though variable. Most part-time students at night school are funded by their employers.

PROGRAM PROJECTIONS

The environmental programs at the University of Toledo anticipate faculty growth in numbers over the next few years. An individual with expertise in air pollution is needed if the program is to remain abreast of societal needs; and faculty in hydraulics, hydrology, and water resources are needed to relieve teaching loads in these areas--loads now being carried by Ph.D. candidates, team-teaching by existing faculty, or industrial personnel. Future program developments may bring about an industrial hygiene program, especially with the legislative impetus and demands of the Occupational Safety and Health Act and the Toxic Substances Control Act. A doctoral program in the environmental area is under consideration.

Faculty note the need to integrate air, water, and solid waste control training within environmental programs rather than focusing on them as completely separate areas of concern. Energy programs must also be considered.

COURSE DESCRIPTION

400 Level and below are Undergraduate Courses.
500 and 700 Level are Graduate Courses.

Chemical Engineering:

462 Introduction to Biochemical Engineering - Application of the principles of chemical engineering to biological processes involving living organisms. Microbial kinetics, fermentation pathways and batch and continued fermentation will be some of the topics covered. (3 q.h.)

463 Biochemical Engineering Processes - Study of the unit operations of biochemical engineering, pointed toward the design of systems involving living organisms, including the production of food, pharmaceuticals, and potable water. (3 q.h.)

465 Unit Operations of Industrial Waste Treatment - Industrial waste treatment is approached through a discussion of the fundamental principles underlying each significant treatment process or operation; following a study of the basics, empirical formulae are used to size and cost waste treatment plants. (3 q.h.)

466 Advanced Waste Treatment - The theme of the course is the use of waste water as a raw material for the production of industrial and/or potable water. The latest and most advanced processes for accomplishing this will be discussed including reverse osmosis, ion exchange, physical chemical treatment, tertiary filtration, activated carbon absorption, etc. (3 q.h.)

Civil Engineering:

361 Introduction to Water Supply - An introductory study of water supplies, including planning and development. Water treatment unit operations and their proper selection are studied. The basic analysis of water supply and distribution systems including a brief review of desired chemical and biological characteristics of water are studied. (3 q.h.)

362 Introduction to Waste Treatment - An introductory study of waste collection and treatment systems common to rural and metropolitan areas which utilize chemical and/or biological waste treatment processes. Waste characteristics and relationship to both treatability and stream compatibility are studied. Treatment unit operations will be reviewed in a manner so that proper selection dependent upon waste characteristics is learned. (3 q.h.)

461 Environmental Engineering Chemistry - A detailed study of the chemistry involved in the determination and progression of inorganic and organic materials which significantly contribute to water pollution. Emphasis is made to relate the engineering significance of each chemical species examined. (3 q.h.)

462 Environmental Engineering Chemistry Laboratory - Laboratory exercises utilizing standard procedures for inorganic and organic analysis of significant water pollutants. (3 q.h.)

463 Applied Hydraulics for Civil Engineers - The study of open channel flow, flow measurement, natural runoff and stream gaging. Aspects of ground water flow relative to well development and resultant unconfined drawdown, along with flow through porous media, are studied. Theory of sedimentation is examined. (3 q.h.)

464 Physical and Chemical Processes for Water and Wastewater Treatment - Physical and chemical processes for water and waste water renovation. Current theories of coagulation and partical aggregation, sedimentation filtration, adsorption, ion exchange, reverse osmosis and ultrafiltration, chemical oxidation, gas transfer and corrosion. (3 q.h.)

465 Theory of Biological Waste Treatment Processes - Aerobic and anaerobic biological processes for domestic and industrial waste water treatment. Current theories of estuary and river modeling, activated sludge processes, trickling filtration processes, oxidation ponds, nitrification and denitrification process. Anaerobic decomposition processes. (3 q.h.)

466 Aspects of Treatment Plant Design - Introduction to environmental and sanitary engineering design. Design of selected water and waste treatment plant operations utilizing knowledge gained from prerequisite coursework. (3 q.h.)

467 Environmental Engineering Microbiology - An introductory study of fundamental microbiology and biochemistry of microorganisms of importance to biological waste treatment operations. The application of these fundamentals to the design of biological waste treatment processes, the optimization of existing facilities and the basic understanding of natural purification processes will be examined. (3 q.h.)

468 Solid Wastes Engineering - A basic study of solid waste materials including origin, form, stability, environmental effects, methods of disposal and new techniques for reclamation and recycling. (3 q.h.)

469 Environmental Engineering Microbiology Laboratory - The identification of microbes and microbial properties which contribute to favorable and adverse effects upon (1) natural ecological systems and (2) biodegradation-waste treatment systems. (3 q.h.)

Engineering Science:

290 Energy and the Environment - The purpose of the course is to develop a greater awareness and understanding of the vital role

290 (Cont'd) - of energy in the total world society. Study of the uses on energy in the achievements of man, its limitations and potentialities as well as a survey of energy sources, conversion processes and cycles, and ultimate disposition. Environmental and economic implications of energy utilization in the modern world. (4 q.h.)

455 Nuclear Engineering I-An introduction to general problems in the field of nuclear engineering. Atomic structure, the decay of radioactive nuclei, nuclear reactions and radiation detection are considered in some detail. (3 q.h.)

456 Nuclear Engineering II - Health physics and biological radiation protection, radioisotope application neutron interactions, and the steady state reactor core are covered. (3 q.h.)

457 Nuclear Engineering III - Transient reactor behavior and control, radiation damage and reactor materials, nuclear heat transfer, and current nuclear reactors are studied. (3 q.h.)

461 Air and Water Pollution Control - Routes to solving environmental problems will be explored from the basic premise that environment control is no different from any other complicated processing problem and only requires the application of existing technology to achieve environmental control. In seeking control techniques, the interrelation between air, water and solid waste disposal will be emphasized. (4 q.h.)

465, 565/765 Air Pollution: Causes and Effects - The events leading to, sources of, and health effects associated with air contamination. Meterology, dispersion and concentration of pollutants from point sources. The automobile and its relation to air quality. (3 q.h.)

466, 566/766 Air Pollution: Control - A study of sampling and source analysis will define the magnitude of industrial sources of pollution. Control of particulates and gases. Control of sulphur and nitrogen oxides from stationary sources; automobile anti-pollution measures. Legal and regulatory aspects of air pollution control. (3 q.h.)

467, 567/767 Air Pollution: Instrumentation - A wide variety of instrumentation will be used to define and measure the extent of air pollution. High volume particulate sampling, SO monitoring, flow rate determination, efficiency checks on electrostatic precipitation, automobile exhaust analysis for unburned hydrocarbons, carbon monoxide, nitrogen oxides. (3 q.h.)

470, 570/770 Control of the Environment - An introductory study of basic scientific, technical and socio-political questions and issues pertaining to the interrelationship between man and the environment. Four to five trips to typical pollution control installations will be required. (4 q.h.)

Engineering/Chemical Engineering:

563/763 Biochemical Engineering Processes - An extension of the principles of biochemical engineering to the design of chemical plants employing biological catalysts. (3 q.h.)

565/765 Unit Operations of Industrial Waste Treatment - Theory and practice of industrial waste treatment preceded by discussion and investigation of basic principles of conventional sewage treatment. (3 q.h.)

566/766 Advanced Waste Treatment - The application of chemical engineering unit processes to the renovation of waste water. Topics include reverse osmosis, physical-chemical treatment, ion exchange and carbon adsorption. (3 q.h.)

667/867 Special Topics in Industrial Waste Disposal - Study and review of current topics from literature and practice of industrial waste disposal. (2 q.h.)

Engineering/Civil Engineering:

556/756 Urban Transportation Design - Travel characteristics; theory of urban travel and trip distribution models; Modal split; traffic assignment models; transportation planning and its relation to social, environmental and aesthetic considerations. Transport technology and the quality of urban life. (3 q.h.)

561/761 Environmental Engineering Chemistry - A detailed study of the chemistry involved in the determination and progression of inorganic and organic materials which significantly contribute to water pollution. Emphasis is to relate the engineering significance upon the environment of each chemical species examined. (3 q.h.)

562/762 Environmental Engineering Chemistry Laboratory - Laboratory exercises utilizing standard procedures for inorganic and organic analysis of significant water pollutants. Selected experiments relating to water and waste treatment. Selected reports pertaining to advanced analytical methods are made. (3 q.h.)

563/763 Applied Hydraulics for Civil Engineers - The study of open channel flow, flow measurement, natural runoff and stream gaging. Studies of friction factors in full flowing conduits are made. Aspects of ground water flow relative to well development and resultant unconfined drawdown, along with flow through porous media are studied. Factors affecting vortex development of various liquids and the theory of sedimentation are examined. (3 q.h.)

564/764 Physical and Chemical Processes for Water and Waste Water Treatment - Physical and chemical processes for water and waste water renovation. Current theories of coagulation and particle aggregations, sedimentation filtration, adsorption, ion exchange, reverse osmosis and utrafiltration, chemical oxidation, gas transfer and corrosion. (3 q.h.)

565/765 Theory of Biological Waste Treatment Processes - Aerobic and anaerobic biological processes for domestic and industrial waste water treatment. Current theories of estuary and river modeling, activated sludge processes, trickling filtration processes, oxidation ponds, nitrification and denitrification process. Anaerobic decomposition processes. (3 q.h.)

566/766 Aspects of Treatment Plant Design - Introduction to environmental and sanitary engineering design. Design of selected water and waste treatment plant operations utilizing knowledge gained from prerequisite course work. Sedimentation, filtration, biological and chemical treatment process operations are designed. (3 q.h.)

567/767 Environmental Engineering Microbiology - An introductory study of fundamental microbiology and biochemistry and microorganisms of importance to biological waste treatment operations and systems relating to water resources management. The application of these fundamentals to the design of biological waste treatment processes, the optimization of existing facilities, the planning of water purification processes will be examined. (3 q.h.)

568/768 Solid Waste Engineering - A basic study of solid waste materials including origin, form, stability, environmental effects, methods of handling, methods of disposal and new techniques for reclamation and recycling domestic and industrial waste materials. Theories for use in planning of waste collection systems are also developed. (3 q.h.)

569/769 Environmental Engineering Microbiology Laboratory - The identification of microbes and microbial properties which contribute to favorable and adverse effects upon (1) natural ecological systems, and (2) biodegradable waste treatment systems. (3 q.h.)

623/823 Ground Water and Seepage - Mechanics of flow of water thru soil. Control of ground water. Flow nets. Application of comformal mapping to ground water problems. (3 q.h.)

INSTITUTION: UNIVERSITY OF UTAH

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.), Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) in Civil Engineering

CONTACT:
Dr. David W. Eckoff
Associate Professor, Engineering
University of Utah
Salt Lake City, Utah 84112
(801) 581-7200 x 6937

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The University of Utah environmental engineering programs are administered through the Department of Civil Engineering. The program, at the baccalaureate level consists of an environmental option, but graduate students at all levels may pursue environmental engineering as an area of specialization.

In addition to the general civil engineering curriculum, the programs place strong emphasis on courses in air pollution, water and wastewater design, and solid waste management. These courses are especially well represented in the graduate level offerings.

Students and faculty utilize a multitude of teaching and research laboratories within the College of Engineering. These facilities, numbering over 30, are well equipped, up-to-date, and house a number of advanced research projects. Included in the main engineering building are the following laboratories, in partial listing: nuclear reactor; optical mechanics; supersonic wind tunnel; scanning electron microscope; transmission electron microscope; high altitude measurements; and, electron paramagnetic resonance.

The environmental engineering programs in the University of Utah Civil Engineering department, prepare graduates for occupations in environmental areas of solid waste, air, water, and wastewater. Technical elective courses in urban systems, transportation and planning prepare graduates of these programs for planning, management and administrative jobs as well as for the pollution control and abatement occupations.

PROGRAM REQUIREMENTS

Any postsecondary student who successfully gains admittance to the University of Utah may be admitted to the College of Engineering.

Academic background and test scores, however, indicate the level at which the student begins the course of study.

The baccalaureate students are encouraged to identify a major area of study as soon as possible. The first two years, however, may be completed within the College of Engineering's common first two-year schedule of courses.

In order to be eligible for the Bachelor of Science degree, the civil engineering student must complete at least 190 quarter hours, and be registered in the department for six consecutive quarters prior to registration.

The first two years of the baccalaureate program include strong emphasis on chemistry, physics and mathematics. The junior year usually includes: the completion of 33 1/2 quarter hours of civil engineering courses (numbered at the 300 level); and, 15 quarter hours of mechanical, industrial and electric engineering courses (at 300 level). The fourth year program includes the selection of a minimum of 19 quarter hours in technical electives. It is in this requirement that the environmental student may select: CE 554, 555, 556, 560, 562, 563, 565 or 566. The remaining 29.5 quarter hours include: 12 quarter credits liberal education; and 17.5 quarter hours civil engineering.

The Master of Science requirements include the following: 45 quarter credit hours including 9 quarter hours of thesis; a comprehensive examination; thesis defense.

The Doctor of Philosophy degree includes special requirements and courses of study as outlined by the departmental advisors.

Fellowships and assistantships are available to students. A partial listing follows: Phillips Petroleum Fellowship; University Research Fellowship; Water Pollution Fellowships; Steed Memorial Scholarship; and, John R. Call Scholarship.

CURRENT FACULTY, STUDENTS, GRADUATES

The current full-time faculty is composed of seven total members. The teaching component is made up of 4.5 cost-centered faculty and .5 full-time-equivalent from two departments to teach cross-listed courses (Biology and Geography departments). There are .5 cost-centered research personnel.

Currently the student enrollment includes 12 male and three female seniors for a total of 15 senior baccalaureate students. There are 10 full-time Master's level students: eight male and two female; two Ph.D. candidates bring the total number of graduate students to 12.

Per annum graduates have averaged approximately 10 at the baccalaureate level and five at the graduate level, over the last three years. These are included in the average per annum number of civil engineering graduates which numbers approximately 35.

Although the graduates of these programs encounter few, if any, obstacles to employment, approximately 80% of the baccalaureate students enter graduate programs. Approximately one-half of these will attend Stanford, MIT, Utah State University and UC Davis. The other one-half remain at the University of Utah.

PROGRAM PROJECTIONS

There are no faculty increases or decreases anticipated over the next few years. One staff replacement will be sought in 1978-79.

The program enrollment is considered to be stable at present. No significant growth is anticipated.

There is some discussion, at present, regarding a very slight shift in program emphasis. This shift would include an added accent on urban systems in conjunction with environmental engineering. This would, overall, offer a program in environmental systems. No time-lines have been established regarding this change.

COURSE DESCRIPTION

Undergraduate courses:

CE 131 Dynamics - Kinematics of particles and rigid bodies in fixed and moving coordinate systems; kinetics of particles and rigid bodies; work, kinetic, and potential energy; impulse, linear and angular mementus; Euler's equations; gyroscopic motion and elementary vibration theory. (Jointly listed as ME 131) (3 q.h.)

CE 20 Urban Systems - Zoning, street systems, and municipal facilities. (3 q.h.)

CE 341 Soil Mechanics I - Structure, texture, sampling, classification density, consistency, stress, distribution, strength, consolidation, capilarity, permeability of soils. (4 q.h.)

CE 352 Hydrology - Surface and groundwater hydrology, flood and drought analysis, reservoir operational studies. (3 q.h.)

CE 360 Water Treatment and Waste Disposal - For Non-Civil Engineers. Methods of water treatment, routine laboratory testing, protection of systems, domestic waste disposal by water carriage and non-water carriage methods, small unit and municipal disposal methods. (3 q.h.)

CE 363 Water Supply and Sewerage - Principles of design, construction and operation of water and wastewater systems and treatment works. (4 q.h.)

CE 370 Transportation Engineering - Introduction to basic planning, design, and operational principles of various modes of transportation for urban and regional applications. (3 q.h.)

Graduate courses (and upper division):

CE 517 Matrix Methods of Structural Analysis - Application of matrix methods in bridge analysis and continuous structures. (3 q.h.)

CE 520 Regional Systems - Principles of planning on a regional basis, integration of urban areas, recreational facilities, transportation systems, industrial sites, etc. (4 q.h.)

CE 525 Elements of City Planning - An investigation of methods, techniques, and procedures, which characterize city planning as it has emerged up to the present time, encompassing an understanding of the physical environment as well as the recognition of the economic, social, and political forces of society. (Jointly listed as Geography 525) (3 q.h.)

CE 527 Principles of Regional Planning - A survey of the theory and problems of regional development, including principles of the location of economic activity, theories of regional growth, and public policy for development of regions. (Jointly listed as Geography 527) (3 q.h.)

CE 530 Vibrations - Free and forced vibrations of discrete linear systems with and without damping: Lagrange's equations and matrix methods for multiple degree of freedom systems, isolation of shock and vibration. Applications including vibrations in machines and structures. (Jointly listed as ME 530)(4 q.h.)

CE 554 Water Resource Engineering - Elements of water resources engineering, river engineering, hydraulic structures, economic and environmental effects of water resources developments. (4 q.h.)

CE 556 Environmental Fluid Mechanics - Principles of transport and mixing processes in air and water. Effects of advection, density currents, turbulence and Fickian diffusion on pollution in streams, lakes, estuaries, seas and the atmosphere. Outfall and intake planning considerations. (4 q.h.)

CE 557 Hydraulic Systems - Overall effects of hydraulic systems and structures, considerations in hydraulic design. (4 q.h.)

CE 560 Solid Waste Management - Quantities and composition of various classes of solid waste; storage and collection; design and operation of collection systems; records, finance, personnel and systems management. (4 q.h.)

CE 561 Air Pollution Ecology - Identification and evaluation of the sources, fate, and effects of air pollution in the environment. (Jointly listed as Biology 578) (4 q.h.)

CE 562 Environmental Sanitation - Dry refuse disposal, insect and rodent control, air pollution, control, housing, institutional sanitation, food handling, industrial hygiene and other environmental health problems. (4 q.h.)

CE 563 Air Pollution Control Techniques - Air pollution emission sources, behavior of pollutants in the atmosphere, theory and practice of control of particulate and gaseous air pollutants at their sources. (Jointly listed as Ch.E. 563) (4 q.h.)

CE 564 Environmental Engineering Chemistry - Sampling methods and principles and practice of physical, chemical and biological analyses of water, wastewater and solid wastes. (3 q.h.)

CE 565 Design of Water and Wastewater Systems - Design of water distribution systems and treatment works, design of wastewater collection systems and treatment works, stream pollution control. (4 q.h.)

CE 566 Environmental Quality Management - Application of scientific, engineering and management technologies in the solution of both small and comprehensive environmental quality problems. (4 q.h.)

CE 620 Advanced Urban Systems - The theory and practice of urban systems engineering. (3 q.h.)

CE 656 Advanced Hydrology - Consumptive use, water quality, statistical methods, maximum possible storms, design floods. (3 q.h.)

CE 659 Ground Water Hydrology - Classification of rocks and their water bearing properties, elementary theory of ground water movement, mechanics of well flows, well practices. (3 q.h.)

CE 678 Intercity Transportation Planning - Analysis and planning of multimodal rural and intercity transportation systems on statewide, national, and international scales. Emphasis is placed on such areas as planning, methodology, needs studies, travel demand estimation, freight movements, socio-economic an political impacts. (3 q.h.)

CE 661 Urban Water Supply Systems - A water supply requirements, supply sources, kinetics and process design, quality control and distribution for municipal and industrial waters. (4 q.h.)

CE 662 Urban Wastewater Systems - Wastewater collection system design, treatment criteria, kinetics and process design, advanced waste treatment and water reclamation for municipal and industrial wastewaters, receiving water quality requirements and disposal practices. (4 q.h.)

CE 666 Advanced Waste Treatment - Applications and design of facilities for advanced waste treatment of municipal and industrial wastes. Processes include soil systems, particulate removal, chemical precipitation, physical adsorption, demineralization through membrane processes and ion exchange, and biostimulant removal. (4 q.h.)

CE 667 Sanitary Engineering Unit Operations - Design and analysis of bench-scale and pilot plant systems for study of water and wastewater treatment processes and solid waste processing and disposal. (4 q.h.)

CE 676 Urban Transportation Planning - Urban transportation problems; theories and process of transportation planning; definition of goals and objectives, modal demand analysis, supply systems characteristics; formulation of transportation plan; evaluation principles and criteria; implementation; case planning studies. (3 q.h.)

CE 744 Advanced Vibrations and Wave Propagation - Vibrations of strings, rods- membranes, beams, shafts and plates; traveling and standing waves; reflection, diffraction and distortion of waves; surface waves; nonlinear oscillation. (3 q.h.)

INSTITUTION: UNIVERSITY OF WISCONSIN - MADISON (UWM)

PROGRAM: Civil and Environmental Engineering
DEPARTMENT: Civil and Environmental Engineering (C.E.E.)
DEGREE: Bachelor of Science (B.S.)

CONTACT: Dr. William Edward Saul
1415 West Johnson
2205 Engineering Building
Madison, Wisconsin 53706
(608) 262-3542

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Civil and Environmental Engineering (CEE) offers a curriculum that provides a balanced program of technical and non-technical courses to meet the needs of students interested in studying civil and environmental engineering. Many special programs are offered at both the undergraduate and graduate levels. These include water resources engineering, ocean engineering, remote sensing, city planning, solid wastes disposal and water chemistry. The discussion here is limited to the B.S. degree in Civil and Environmental Engineering.

PROGRAM REQUIREMENTS

It is recommended that the 16 units needed for admissions include four years each of mathematics and English, and one year each of chemistry and physics. Entering freshmen are placed in mathematics courses on the basis of both their high school mathematics preparation and scores on required placement tests.

The Freshman Professional Orientation course helps students develop an understanding of the varied facets of the engineering profession and achieve maximum benefit from their freshman year in engineering. Speakers include outstanding faculty members from the College of Engineering and from other colleges of the University, as well as noted people in industry. All engineering freshmen are required to enroll in Engineering Freshman Professional Orientation, or an appropriate substitute, during the first semester in which it is offered during their residence.

A B.S. degree requires 135 semester hours. This includes 74 credits of electives in the fields of natural science, liberal studies, civil and environmental engineering methods, designated electives from hydraulics, sanitary engineering, structures and geotechnical engineering, surveying-photogrammetry and remote sensing or transportation and city planning, technical, and free. The remaining 61 required credits are taken in various engineering departments including CEE and the mathematical areas. This program flexibility practically insures that no two students who graduate from the College of Engineering have necessarily taken identical programs.

CURRENT·FACULTY, STUDENTS, GRADUATES

Some sources of research funding have been Sea Grant Program, National Science Foundation, National Aeronautics and Space Administration, UWM Water Resources Center, Institute for Environmental Studies, U.S. Environmental Protection Agency, City of Madison, Wisconsin Department of Natural Resources.

Laboratory facilities include fluid mechanics, hydraulics, field study, sanitary, and water chemistry. A new Water Resources laboratory is presently under construction and will concentrate most of the water-related research from all departments on the campus in one building. The Madison Metropolitan Sewerage District (MMSD) has cooperated with UWM in establishing the sanitary engineering field laboratory and pilot plants at their Nine Springs Sewage Treatment Plant.

Fifteen percent (80) of the 526 civil and environmental engineering students are female. There are over 100 graduates per year. The largest influx of transfer students does not come from other than four-year institutions.

Financial aids include scholarships, grants, loans, and employment programs. Full-time faculty numbers 28, part-time 2.

The Engineering Placement Office offers many services to students and graduates. One is a Pre-Selection Program making it possible for each student to register with the Placement Office during the spring prior to the year of graduation. By doing so the student's interview form is printed in quantity and is made available to employers in advance of campus recruiting visits.

The cooperative programs offered through the College of Engineering allow undergraduates to alternate periods of college attendance with periods of practical work experience.

Opportunities also exist for students to study engineering in Mexico, France or Germany. A "B" average and college level knowledge of the native language are required for this international study opportunity.

PROGRAM PROJECTIONS

The department sees a change in long-range goals and objectives of the program when funding on a national level changes.

ADDITIONAL INFORMATION

Numerous workshops are held in cooperation with the College of Engineering - Madison and University of Wisconsin - Extension. Extension is one of approximately 30 institutions in the University of Wisconsin System and Engineering sponsors many workshops, seminars, institutions, etc.

The Institute for Environmental Studies (IES) University of Wisconsin - Madison, which was founded in 1970, is a campus-wide organization to develop interdisciplinary programs pertaining to man and his environment. It combines an environmental curriculum with a comprehensive research program for graduate and undergraduate students. The teaching staff of over 50 professors and lecturers has ties with 23 departments besides environmental studies.

COURSE DESCRIPTION

Undergraduate/Graduate courses (a partial listing):

320 Sanitary Engineering - Fundamental sanitary aspects of environmental engineering; topics: Role of the engineer in the control of the environment; water supply and wastewater problems, solid waste disposal; air pollution; and administration in environmental engineering. (3 s.h.)

321 Environmental Pollution Control for Non-Engineers - Water, land, and air pollution control technology to show the engineering approach to pollution problems, to outline solutions based on current technology, and to consider technical and economic constraints on solutions. (3 s.h.)

325 Design of Water Distribution and Wastewater Collection Systems - Application of basic principles in sanitary engineering and hydraulics to the design of conduits, water distribution systems; reservoirs, pumping stations, and storm water and sanitary sewage systems and appurtenances. (3 s.h.)

326 Design of Water and Wastewater Treatment Plants - Unit operations in water and wastewater treatment; sedimentation, chemical coagulation, ion exchange, filtration, disinfection; design of a water treatment plant; the natural or self-purification of water; physical, chemical and biological processes for treatment of wastewater; sludge treatment and disposal; design of a sewage treatment plant. (3 s.h.)

327 Solid Wastes Engineering - Basic concepts in designing, evaluating, and operating solid wastes storage, collection, and disposal systems; land and incineration disposal methods; air pollution as related to solid wastes legal, political and administrative considerations. (3 s.h.)

370 Transportation Engineering - Characteristics of transportation supply and demand; measuring and estimating demand; social and environmental impacts; planning of transportation systems; characteristics of transportation modes; interaction between modes; mode interfaces; transportation technology; economics; public policy, implementation and management. (3 s.h.)

415 Water Resources Engineering - Application of principles of hydraulics, hydrology and water control to problems in erosion control, flood control, water power, irrigation, navigation, and river basin planning; includes design principles of water relating structures. (3 s.h.)

416 Optimization and Simulation of Water Resources Systems - Basic concepts of systems analysis applied to water resources. Introduction to optimization and simulation methodology. Development and application of water quality models and water resources management techniques. Use of stochastic and parametic hydrologic models. (3 s.h.)

421 Water Supply and Pollution Control - Elements of water supply and wastewater treatment processes, and pollution control. (2 s.h.)

423 Air Pollution--Effects, Measurement, and Control - The influence of man-caused pollution on the atmosphere, globally and locally. Evaluation of human health, economic, and aesthetic effects of air pollution. Techniques for measurement of atmosphere pollutant concentrations and determination of local and regional air quality. Detailed presentation of air pollution sources and methods for their control. The role of local, state and federal government in air pollution control. (3 s.h.)

424 Water Analysis - Lab methods and the interpretation of lab results for chemcial and biological analyses of water and wastewater. (3 s.h.)

516 Ocean Environment - Introduction to sea and fresh water environments. Course is four sections: biological oceanography, chemical oceanography, geological and geophysical oceanography, and physical oceanography. Each independent of the others, and taught separately. Student can take any number of sections. (1-4 s.h.)

521 Industrial Waste Treatment - Characteristics and composition of industrial wastes, sampling and methods of anlaysis of industrial wastes, and remedial measures for treatment, in-plant conservation, material, reclamation, recycling and disposal. (2 s.h.)

525 Radioactive Waste Treatment - Methods and unit processes used for the treatment of radioactive wastes; effects of usual water and sewage treatment processes on the removal of radioactive nuclides, and ultimate disposal of radioactive wastes. (3 s.h.)

552 Remote Sensing of the Environment - Principles, characteristics and applications of remote sensing of the environment. Emphasis on airborne remote sensing of the earth's environment. (3 s.h.)

556 Romote Sensing Image Interpretation - Techniques of enhancement and quantification of remote sensing imagery. Emphasis on processing and analyzing data gathered by airborne and satellite sensors. Techniques to quantitatively analyze data from photography, electro-optical scanners, satellite systems, and radar and passive microwave systems. A five-week practicum with applications to: agriculture and forestry, geology and soils, water quality, and urban and regional planning. (3 s.h.)

570 Environmental Impacts of Transportation Systems - Intermediate level. Nature of the ecosystem and ecosystem modelling, the nature of transportation produced impacts on man's social, economic, physical and emotional well being, on wildlife, natural areas, agricultural areas; environmental economics; measuring and evaluating environmental quality, and citizen tactics in response to environmental issues. (3 s.h.)

572 Airports - The nature of air travel and aircraft technology; environmental impacts; airport operations and flight control; airport planning and design; site selection, configurations, design details; new airport concepts; terminals, support functions; airport access; heliport design and operation. (2 s.h.)

580 Water Chemistry - Chemistry of the elements in fresh and marine water; acidic and basic, precipitation, complexation, oxidation-reduction, sorption, and biochemical reactions in natural waters and water treatment processes. (3 s.h.)

621 Solid Waste Engineering II - Detailed engineering and management considerations related to the design and operation of solid wastes collection and disposal systems; solid wastes survey; systems approach to design; design of land disposal operations; incinerator evaluations and design; composting; salvage systems; special wastes; new methods of collection and disposal; administrative considerations. (3 s.h.)

624 Cost Engineering for Water Pollution Control - Use of forecasting, cost estimating and analysis, and optimization methods for the design of sanitary engineering systems, with major emphasis on water and waste-water treatment. (2-3 s.h.)

INSTITUTION: UNIVERSITY OF WISCONSIN-MADISON

PROGRAM: Water Resources Management, Environmental Monitoring, Land Resources

DEPARTMENT: Institute for Environmental Studies

DEGREE: Master of Science in Water Resources Management (M.S.)
Master of Science and Doctorate in Environmental Monitoring (M.S.) (Ph.D)
Master of Science and Doctorate in Land Resources (M.S.) (Ph.D.)

CONTACT: Dr. Reid A. Bryson, Director/Dr. Arthur B. Sacks
Institute for Environmental Studies
1339 Meterology & Space Science Building
1225 West Dayton Street

Coordinator of Academic Program
Institute for Environmental Studies
70 Science Hall
550 North Park Street

University of Wisconsin-Madison
Madison, Wisconsin 53706

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Institute for Environmental Studies offers interdisciplinary education for undergraduate and graduate students. Undergraduates in the College of Letters and Science are currently developing environmental studies majors in consultation with the Institute of Environmental Studies (IES) through the Individual Major Program. A formal undergraduate major in environmental studies is before the College of Letters and Science for its review. Degrees in Environmental Studies, per se, are not available at the University of Wisconsin-Madison at this time. However, students may get involved in this area through 1) association with IES, 2) a number of cross-departmental programs, and 3) a wide variety of departments currently emphasizing environmental studies.

IES administers three graduate programs: an M.S. in Water Resources Management, and M.S. and Ph.D. degrees with majors in Land Resources and Environmental Monitoring. Possibilities for a graduate program in Environmental Systems Analysis are currently being explored with the Graduate School and the University Administration.

PROGRAM REQUIREMENTS

An individual with an undergraduate or graduate degree in the biological sciences, earth sciences, economics, engineering, law, urban and regional planning, landscape architecture, mathematics, journalism, political science, or other suitable fields may apply for admission to the Water Resources Management Program. The general admission requirements of the Graduate School apply. Two options are available. Most students elect the 45-credit option; however, individuals with three or more years of professional experience and/or those with advanced degrees may elect the 30-credit option.

Double masters programs can be arranged with the consent of appropriate departments. Basic requirements for the 45-credit hour option include a minimum of 30 credits in the core curriculum plus a minimum of 15 credits within an area specialty. This option generally requires four semesters and one summer session. In the second option, a minimum of 30 credits in the core curriculum is required. The choice of courses should supplement relevant experience. This option generally requires two semesters and one summer session.

Students should enter the interdisciplinary Environmental Monitoring program with depth in a discipline. Normally this discipline will be in one of the natural science or engineering fields such as botany, chemistry, civil and environmental engineering, computer science, electrical engineering, forestry, geography, geology and geophysics, meteorology, physics, soil science, or zoology. Physical planning and/or design fields such as landscape architecture or urban and regional planning are also appropriate disciplines. Applicants presenting other backgrounds may be considered for admission with deficiencies. As part of their applications, students must submit a statement indicating the nature of their particular interdisciplinary program interests and three letters of recommendation. All applicants must meet the general requirements of the Graduate School.

A minimum of 30 credits of graduate study is required for the M.S. degree. Of these 30, students must meet Depth, Breadth, Interdisciplinary Synthesis, Thesis, and other requirements. Similar requirements apply for the Ph.D. degree. At the present time, the Environmental Monitoring Program stresses the application of remote sensing techniques to environmental problem-solving.

The Land Resources Program is most appropriate for individuals with undergraduate training or experience in resource planning or management; natural or earth sciences; engineering or design; land institutions; or the economics, history or geography of land. Applicants with backgrounds in areas other than these, but with a strong interest in land resource problems, may enter the program with special permission. The general regulations of the Graduate School apply to all admission. In addition, persons applying to this degree must submit a statement indicating the nature of their specific program interests as well as three letters of recommendation.

The M.S. requires a minimum of 30 credits; the Ph.D. requires a minimum of 64 credits. The degree format is structured to foster both depth and breadth in knowledge related to land resource problems. A student may draw freely from the course offerings of several departments, but an individual's program as a whole must be directed toward specific goals with the student's research related to the same goals as his/her course work selections. Candidates for the M.S. degree must complete a thesis or a supervised research paper in lieu of a thesis. Ph.D. candidates are required to submit a research thesis.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of 52 faculty comprise the Institute staff. Most are departmentally based and contribute only part-time to the Institute; however, five faculty members have their primary homes within the Institute, which has the ability to tenure faculty. Whenever possible, faculty appointments are joint with disciplinary departments.

There are 72 students in the Water Resources Management M.S. program; seven M.S. and seven Ph.D. candidates in the Environmental Monitoring program; and 21 M.S. and 14 Ph.D. students in the Land Resources program.

Graduates of the Water Resources program have had no difficulty finding employment (approximately 20 are graduated each year). All are employed in their field; 50 percent in the private sector, 50 percent in government. The Land Resources program was begun in 1976, and the Environmental Monitoring program in 1977.

PROGRAM PROJECTIONS

The IES offerings may be expanded to include environmental health, environmental planning, environmental systems analysis, and energy.

ADDITIONAL INFORMATION

The Institute offers three-week intersession courses for undergraduates. Workshops and seminars in water quality and mining and oil shale development have been presented.

COURSE DESCRIPTION (A partial listing)

101 Forum on the Environment - Lectures, discussions, and field study of environmental problems. Philosophical, political, and social implications are discussed, as well as technical considerations. (3 s.h.)

121 Atmospheric Environment of Man - The interactions of man and his societies with the atmospheric environment. (2 s.h.)

122 Climatic Environments of the Past - Climatic history of the last 10,000 years; the environmental background of history. (2 s.h.)

127 Physical Systems of the Environment - Climatic regimes, land forms, soils, water and life forms at the earth's surface in terms of energy-transforming processes, locational patterns, and changes through time. (5 s.h.)

300 Environmental Management - An integrated, interdisciplinary survey course to give basic understanding of current issues calling for intelligent citizen action. Resource management science, technology, history, organization, and philosophy. (3 s.h.)

321 Environmental Pollution Control for Non-Engineers - An introduction to air, land, and water pollution control technology. Intended to convey the engineering approach to pollution control technology. Intended to convey the engineering approach to pollution problems, solutions, and to define the technological and sociological interface in arriving at these solution. (3 s.h.)

323 Environmental Microbiology - Relationships of microorganisms to their environment and to other organism. The course will cover soil, aquatic, and geomicrobiology, and microbial symbioses. (3 s.h.)

324 Soils and Environmental Pollution - Interaction of soils with environmental contaminants and the role of soils in pollution control. (3 s.h.)

336 Our Hazardous Environment - An analysis of the unexpected: Hazardous elements of our physical environment (such as hurricanes, tornadoes, floods, earthquakes, etc.)--their physical characteristics, regional distribution, economic aspects, and human adjustments. (3 s.h.)

371 Nuclear Energy and the Environment - Fission and fusion processes, nuclear reactors, power plants, radioactivity, biological effects, radiation and thermal releases, governmental regulations' impact on society. (3 s.h.)

400 Environmental Core Studies - Lecture, discussion and field trips for intensive, interdisciplinary study of environmental topics. Technical, political, economic, social, and philosophical implication are included. Past topics include: Alternative Sources of Energy, Predicting Food Supplies, Energy Conservation, Issues in Human Population Control, Environmental Law and Decisionmaking and Environmental Systems Analysis. (2-4 s.h.)

440 Environmental Decisionmaking - The course will examine the environmental decision process within a broad cultural and historical perspective. Emphasis will be upon the socio-politico-economic forces that influence decision-making. (3 s.h.)

441 Environmental Ethics - Treatment of ethical theories with an eye to their adequacy or inadequacy in handling such wrongs as harm to the land, to posterity, to endangered species, and to the ecosystem itself; exploration of the view that not all moral wrongs are based directly or even indirectly upon harm to human beings; critical treatment of possible grounds for that view; inquiry into the notion of the quality of life and the ethics of what have been termed "overcrowded lifeboat situations." (3 s.h.)

506 Modeling and Analysis of Environmental Systems - An upper-level course in systems modeling intended for students in the physical sciences who are interested in applications to environmental problems, and for students in life sciences who are interested in system methods. (3 s.h.)

516 Ocean Environment - A survey of sea and fresh water environments (other than water motion); includes applied marine biology, water chemistry, and geological oceanography. (1-3 s.h.)

535 Atmospheric Dispersion and Air Pollution - The physical principles of transport processes in the atmosphere, and how the processes vary with time and place, resulting in high levels of local and regional pollutant concentration. The environmental implications of air pollution and control strategies for preservation of atmospheric quality. (3 s.h.)

552 Remote Sensing of the Environment - Emphasis on airborne sensing. Characteristics and uses of photography, electro-optical scanners, multispectral imagery, radar imagery, passive microwave sensing, and other sensors. Applications to air and water quality studies, geography and geology, highway and traffic engineering, soils mapping and evaluation, urban and regional planning, and other fields. (3 s.h.)

666 Environmental Monitoring System Study - Interdisciplinary approach to formulation and solution of major environmental problems; problem definition including related issues; alternative solutions and detailed design. (3 s.h.)

719 Water Resources Management Practicum - An interdisciplinary team of students and staff work closely with agency personnel, citizen groups, and/or private sector representatives on the analysis of a contemporary, problem-oriented water resource issue. Physical, biological, economic and social aspects of the issue are integrated into the analysis through the use of small teams and group discussion. Course involves extensive interviewing and literature review. (6 s.h.)

761 Colloquium in Air Pollution - Discussion of current research at the University on emission sources, engineering control of air pollutants, atmospheric modeling, health and plant effects. (1 s.h.)

765 Environmental Monitoring Practicum I - An interdisciplinary workshop that will investigate "real world" environmental problems. Environmental monitoring will be one of the sources of data required for investigation. The topic will be chosen each year by the faculty and students in the Environmental Monitoring Degree Program. The course is intended to be an example of interdisciplinary synthesis and analysis. A comprehensive report will be prepared by the students enrolled. (3 s.h.)

920 Environmental Monitoring and Data Acquisition Seminar - Selected topics dealing with environmental monitoring and data acquisition, with emphasis on remote sensing of the environment. (1 s.h.)

935 Seminar in Air Resources Management - An interdisciplinary investigation seminar focused on a specific current problem in air resource management with staff and students contributing to the development of the issues, methodology, data, analysis, and policy formulation. (2 s.h.)

966 Seminar in Water Resources Planning - Governmental and legal aspects of water resources management; problems of public policy for control and use of water and related land resources. (2-3 s.h.)

INSTITUTION: VANDERBILT UNIVERSITY

PROGRAM: Environmental and Water Resources Engineering/ Environmental Science

DEPARTMENT: Environmental Engineering and Policy Management

DEGREE: Master of Science (M.S.)
Master of Engineering (M. Eng.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Karl B. Schnelle, Jr., Chairman
Department of Environmental Engineering and Policy Management
Vanderbilt University
Nashville, Tennessee 37240
(615) 322-4757

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering began at Vanderbilt as a program in 1962. Five years later Sanitary and Water and Wastewater Resource Engineering became a department. After six major departmental changes, the name became Environmental Engineering and Policy Management.

The primary focus of advanced level studies in this department is on the development of modern quantitative techniques and their application to practical problems encountered in the field of environmental pollution and control. Advanced analytical, numerical, and statistical methods are combined with elements of water quality, systems analysis, hydraulics, biology, and chemistry to provide the necessary background for conducting significant design, planning, and research in the environmental area.

Current research projects include studies on thermal pollution, waste assimilation, stratified flow dynamics, industrial waste treatment, biological waste treatment, effects of pollutants on water quality in reservoirs, and methods of environmental education of the public. Students are all required to use computers in course work and are encouraged to use computer analysis in their research projects. Research needs of the program are served by the Joint University Libraries System which holds more than 1.25 million volumes and a catalogue of approximately 6,400 periodicals. Complete facilities are available for water analysis, including atomic adsorption, spectrophotometry, and gamma-ray spectrometry. Extensive facilities for water and water treatment pilot plants and hydraulic research (including a 60 foot flume) are available. The air pollution laboratory houses a full range of sampling, flow measuring, and analytical equipment, including several automatic recording type instruments. In addition, a partial analytical equipment inventory includes a gas chromatograph, ultraviolet and infra-red spectrophotometers, zeta meter and a recording polaragraph.

PROGRAM REQUIREMENTS

A bachelor's degree in engineering or science, completed with a 3.0 (on a 4.0 scale) grade average is required for admission to the Department of Environmental Engineering and Policy Management. Competence in given areas is a key factor in admission decisions, not necessarily how many courses one may have taken.

The normal requirements for an M.S. degree include the completion, with a B average, of at least twenty-four semester hours of formal course work and the submission of a thesis. Students have the option in this program of following a non-thesis plan which requires thirty semester hours of graduate study, presentation of an oral report to a research seminar on a subject in the field of investigation, and submission of a written account of this work to the supervisory professor.

An advanced professional degree which is especially designed for engineering practicioners who prefer to continue working while engaged in graduate study is available. Students may complete one course at a time and they have seven years to finish the Master of Engineering degree. Thirty semester hours, including twelve hours in the candidate's chosen program, are required. The remaining hours may be approved courses in other programs. At least twelve hours must be chosen from courses designated as Engineering Graduate Professional Courses.

Five options for specialization exist. They are: Water and Wastewater Treatment Engineering, Water Resources, Air Resources, Solid Waste, and Environmental Science. A core curriculum for each has been developed to guide the students through their respective programs. Should the curricula not be pursuant to the needs of a student, then together with his/her advisor, a request for variance may be filed with the director of the program. This request should be made early in the course of a student's study.

A program in Environmental Science requires students to take the following courses: EWRE 222 - Methods of Scientific Research, EWRE 250 - Principles of Water Treatment and Waste Water Disposal or EWRE 280 - Atmospheric Pollution or EWRE 295 - Solid Waste Management, EWRE 270 - Public Health Engineering, EWRE 271 - Environmental Chemistry, EWRE 272 - Microbiology of Water, Wastewater, and Air, EWRE 273 - Environmental Chemistry Laboratory, and finally, MATH 252 - Statistical Analysis for Environmental Scientists and Engineers.

Individuals wishing to pursue the Doctor of Philosophy degree design programs of study, in consultation with their advisors, which are specific to their educational objectives. The doctoral program normally takes two and one-half to three years of work beyond the M.S. degree level. The first two years are generally devoted to coursework and to preparation for the general examination which admits one to doctoral candidacy. Most students require one year to complete the dissertation, work on which ensues after the second year. The final public oral examination is held after the dissertation is submitted, and consists of a thesis defense and an examination of the student's expertise in his/her field of study.

CURRENT FACULTY, STUDENTS, GRADUATES

Including the department chairman, there is the equivalent of nine full-time faculty whose primary focus is on teaching. During 1977, there were six persons enrolled in the Master of Engineering program, sixteen in the Master of Science program, and ten seeking a Ph.D. degree.

Approximately 50 percent of the graduate students are receiving financial assistance. Such aid is available to all M.S. and Ph.D. candidates in amounts up to $4,000 per year plus tuition. The EWRE program has a variety of fellowships and assistantships available. Students who are receiving support from fellowships or traineeships or by research or teaching assistantships may take normal course loads.

While precise figures are not available, it is estimated that 40 percent of the graduates from the past three years have been employed by EPA, 25 percent have been employed by state agencies, 10 percent by other federal agencies, and 25 percent have gone to private consulting firms and industry.

PROGRAM PROJECTIONS

Since its inception, this department has undergone six major upheavals. The result of that constant flux is that officials are now striving to achieve departmental stability.

There is currently a moderate recruitment effort being made. Officials would like to see the master's enrollment level reach forty.

COURSE DESCRIPTION

MATH 252 Statistical Analysis for Environmental Scientists and Engineers - Frequency distributions, central tendency, dispersion, classical distributions, comparison of means and variances, correlation, linear and nonlinear regression. Applications to environmental studies. (3s.h.)

EWRE 222 Methods of Scientific Research - Scientific investigations as illustrated by study of case histories. Preparation for research, hypotheses in science, planning experimentation, the role of chance in scientific discovery, intuition in science; difficulties in research, style and taste in research, strategy in research, scientific knowledge, and social values. (2 s.h.)

EWRE 270 Public Health Engineering - Principles of public health engineering, study of vector control, communicable disease control, milk and food sanitation, refuse disposal, and general environment sanitation. (2 s.h.)

EWRE 271 Environmental Chemistry - Theoretical aspects of physical, organic, and inorganic chemistry as applied to environmental engineering problems. (3 s.h.)

EWRE 272 Microbiology of Water, Waste Water, and Air - Principles of biology and their application to environmental science with emphasis on microbiology of air, water, sewage, and industrial wastes. (4 s.h.)

EWRE 273 Environmental Chemistry Laboratory - Chemical analysis of water and waste water and the laboratory control of water purification and waste treatment processes. (3 s.h.)

EWRE 277 Open Channel Hydraulics - Resistance in open channels. Hydraulic design of channels. Steady, non-uniform flow (backwater curves). Unsteady, non-uniform flows. Method of characteristics. Numerical solutions for unsteady flows. (3 s.h.)

EWRE 278 Hydrology - Hydrologic cycle, study of precipitation, evapotranspiration, stream flow, flood flow, ground water, flood routing, snowmelt, and hydrometerology. (3 s.h.)

EWRE 279 Economics and Law of Air and Water Resources - Economics of air and water resource conservation and development, water rights, public policy and laws relating to air and water resources. (3 s.h.)

EWRE 280 Atmospheric Pollution - Fundamentals of atmospheric pollution and control. Sources and nature of gaseous and particulate air pollutants, relation of meteorological conditions to their dispersal and their effects on health and materials are discussed along with administration, standards, and control of air pollution. (3 s.h.)

EWRE 295 Solid Waste Management - Introduction to problems of solid waste practice; types and quantities of wastes; composting, landfill, incineration; recycling of wastes and product recovery; resource management systems. (3 s.h.)

EWRE 300 Water Quality Management - Effects of physical, chemical, biological, and physiological pollutants in streams, reservoirs, and estuaries; fate of pollutants in the environment; water quality criteria; water quality management methodology. Biological aspects of water quality control. (3 s.h.)

EWRE 318 Systems Analysis for Environmental Engineers - Differential equation models derived from basic principles of heat, mass, and momentum transport, reaction kinetics, and mixing and blending. Digital and analog computers to obtain solutions to equations derived. Application of differential equations to problems such as the dispersal of pollutants in rivers. (3 s.h.)

EWRE 321 Water Treatment Theory and Practice - Drinking water standards, advanced study of theory of operation of water treatment operations and processes, relation of theory and design practice analysis and design of water treatment units. (3 s.h.)

EWRE 322 Waste Treatment Theory and Practice - Theory and practice of biological waste treatment. Treatment of municipal and industrial wastewaters by biological processes. Design and operation of biological waste treatment facilities. Principles and practice of sludge dewatering and disposal. Advanced wastewater treatment. Analysis and design of waste water treatment systems. (3 s.h.)

EWRE 333 Air Pollution Control - Design and operation of air pollution control equipment. Method of application of control in various industries. (3 s.h.)

EWRE 334 Air Pollution Meteorology - Basic meteorology of urban atmosphere and effects on air pollution. Structure and properties of atmospheric boundary layer; atmospheric turbulence and diffusion; isolated point, line, volume, and area sources; buoyant plume rise; building effects; urban climatology and meteorology; urban air pollution models. (3 s.h.)

EWRE 345 Water Resources Engineering - Case studies of important problems in water resources engineering. Topics covered may include stratified flow, thermal pollution, eutrophication, tracer techniques, optimization techniques, submerged jets, hydraulic models, water power engineering, and water resources planning. (3 s.h.)

EWRE 362 Management of Solid Waste Collection Systems - Selected problems pertaining to reference materials, methods of collection, methods of storage, equipment, and transportation. A comparison of municipal, contract, and private collection systems. Financing refuse collection operations, organization, personnel, equipment management, cost accounting and budgeting, and public relations. Analysis and planning of refuse collection systems. (3 s.h.)

EWRE 363 The Management of Solid Waste Disposal Systems - Quantities and composition of refuse, selecting disposal methods, sanitary landfill, analysis of central incineration, composting, salvage, reuse, reclamation, reprocessing, and recycling. Design and analysis of refuse disposal systems. (3 s.h.)

INSTITUTION: VANDERBILT UNIVERSITY

PROGRAM: Environmental Science

DEPARTMENT: Environmental Engineering and Policy Management

DEGREE: Bachelor of Science (B.S.)

CONTACT: Dr. Karl B. Schnelle, Jr., Chairman
Department of Environmental Engineering and Policy
Managment
Vanderbilt University
Nashville, Tennessee 37240
(615) 322-4757

PROGRAM DESCRIPTION:

PROGRAM STURUCTURE

The program in environmental science is designed for those students who are interested in the application of basic science to environmental problems. Many areas of environmental studies are dealt with, including social science, and it includes an in-depth sequence in the basic science of primary interest.

Environmental matters and problems first received attention in the form of a program in 1962. Environmental Engineering and Policy Management (not the original department title) became a department five years later in 1967, offering a B.S. degree. It is important to realize that this department has undergone a tremendous amount of change; there have been six major upheavals since it was first identified as a department. In addition to the B.S. degree, an Engineers' Council for Professional Development accredited B.E. degree in Environmental and Water Resources Engineering (EWRE) is also offered and the largest portion of undergraduate enrollment is in pursuit of the B.E.

The B.S. degree leads to careers in environmental studies, management, or research, with possibilities in both laboratory and field work, or to further study in management, business or law. These graduates are most commonly placed as laboratory analysts, sanitarians, and public health personnel.

Extensive facilities exist for instruction and research. There is modern equipment for chemical, physical and biological analysis of water, wastewater, air, and solid waste located in the EWRE laboratories. The computation laboratory includes a quantitative analog computer and two teletype units for access to the time-sharing digital computer system.

PROGRAM REQUIREMENTS

The School of Engineering bases its decisions on who shall be admitted upon the personal and academic records of the applicants. Applicants should have had at least four units (a unit representing one year's study in a single subject) of high school English, four units of mathematics (algebra, geometry and trigonometry), and two units of science. Also desirable are two units of a foreign language and one of history. In all, there should be fifteen academic units. Applicants must also submit scores received on the SAT (preferred) or ACT examination. Regardless of which of the entrance examinations is taken, all applicants must also take the College Entrance Examination Board achievement tests Mathematics Level I or II and English Composition.

One hundred and twenty-four semester hours are required for the Bachelor of Science in Environmental Science. Students are expected to take charge of their own programs, which should meet their own needs, show purpose, and display appropriate breadth and depth in coverage of the topic. Students have the assistance of faculty advisors when planning curricula.

Fifteen semester credits must be taken of humanities-social science electives, three credits in technology-society, twenty-eight credits of technical electives, and six credits of free electives. A sample of an acceptable curriculum might include eleven credits of chemistry, eleven of geometry and calculus, five to seven credits of engineering principles, four of either botany or zoology, eight of physics, three of statistics and three of computing. In addition to the required electives in each given area and the mathematics and science background, one might take the following major courses: EWRE 151 - Special Topics on Man and His Environment, EWRE 220 - Environmental Problems: Air Pollution and Occupational Health, EWRE 271 - Environmental Chemistry, EWRE 211 - Water and Wastewater Treatment, EWRE 270 - Public Health Engineering, EWRE 272 - Microbiology of Water, Wastewater, and Air, EWRE 200 - Individual Study, EWRE 222 - Methods in Scientific Research, and EWRE 279 - Economics and Law of Air and Water Resources. The technical electives must include nine hours beyond the minimum requirements on one area of science, such as mathematics, statistics, biology, chemistry, geology, or physics.

CURRENT FACULTY, STUDENTS, GRADUATES

There are the equivalent of nine full-time faculty, including the chairman, in this department with the primary attention on teaching. There are nine persons enrolled in the B.S. program, compared to thirty-four in the B.E. In 1975 there were eleven students pursuing the B.S. and in 1976 there were seventeen. Two or three people are awarded the Bachelor of Science in Environmental Science per year.

On a competitive basis, students may apply for a number of scholarships in the School of Engineering. Although a co-op program does exist in the School of Engineering, it is not widely utilized in this department.

A survey of all graduates of this department shows that nearly 40 percent are employed by the Environmental Protection Agency, 25 percent by state government, 10 percent by the federal government and another 25 percent by private industry.

PROGRAM PROJECTION

This department has undergone six complete changes since its inception; as a result, the department is striving to achieve internal stability. It is hoped that enrollment figures will continue to grow at a moderate rate.

COURSE DESCRIPTION

EWRE 150 Man and His Environment - Scientific and engineering principles for enhancement of quality of the total environment emphasis on role of technology and its interrelationships with society. (3 s.h.)

EWRE 151 Special Topics on Man and His Environment - Discussion, readings, and projects in selected areas of environmental concern. (3 s.h.)

EWRE 210 Water Supply and Wastewater Collection - Hydrologic consideration of surface and ground water sources, design of distribution systems, impoundments, and control works. Hydraulics of water supply systems and sewerage works and appurtenances. Functional design of storm and sanitary sewer systems. (3 s.h.)

EWRE 211 Water and Wastewater Treatment - Water quality criteria, unit operations, and processes of water treatment. Chemical and biological characteristics of wastewater; unit operations, and processes of wastewater treatment; stream pollution. (3 s.h.)

EWRE 220 Environmental Problems: Air Pollution and Occupational Health - Intermediate-level consideration of subjects of air pollution and occupational health; sources of air pollution, meteorological aspects, effects, methods of measurement, and control of air pollution. (1-2 s.h.)

EWRE 221 Environmental Problems: Solid Wastes and Radiological Health - Intermediate-level consideration of subjects of solid wastes and radiological health; the collection, storage, volume reduction, reclamation, and final disposal of wastes. (1-2 s.h.)

EWRE 246 Solid Waste Collection Practice - Refuse collection problems, preparation of refuse for collection, methods, equipment planning, transportations, and finance. Organization, personnel management and public relations. (2 s.h.)

EWRE 247 Municipal Refuse Disposal Practice - Quantities and composition of refuse, disposal methods and management. (2 s.h.)

EWRE 271 Environmental Chemistry - Theoretical aspects of organic and inorganic chemistry applied to environmental engineering problems. (3 s.h.)

EWRE 272 Microbiology of Water, Waste Water, and Air - Emphasis on microbiology of air, water, sewage, and industrial wastes. (4 s.h.)

EWRE 273 Environmental Chemistry Laboratory - Chemical analysis of water and waste water and control of water purification and waste water treatment processes. (3 s.h.)

EWRE 276 Ground Water Hydrology - Occurrence and flow of ground water. Basic concepts of permeability and capillarity. (3 s.h.)

EWRE 277 Open Channel Hydraulics - Resistance in open channels. Hydraulic design of channels. Steady and unsteady non-uniform flows - characteristics and numerical solutions. (3 s.h.)

EWRE 279 Economics and Law of Air and Water Resources - Economics of air and water resource conservation and development, water rights, public policy and laws relating to air and water resources. (3 s.h.)

EWRE 280 Atmospheric Pollution - Fundamentals of atmospheric pollution and control. (3 s.h.)

EWRE 281 Sampling and Analysis of Polluted Atmospheres - Photochemical effects and kinetics of polluted atmospheres. Modern methods of detection of air pollutants by laboratory and continuous analysis. (2 s.h.)

EWRE 295 Solid Waste Mangement - Solid waste management: types and quantities of wastes, collection and transportation of wastes; composting, landfills, incineration; recycling of wastes and product recovery; resource management as a system. (3 s.h.)

INSTITUTION: VANDERBILT UNIVERSITY

PROGRAM: Environmental and Water Resources Engineering (EWRE)

DEPARTMENT: Environmental Engineering and Policy Management

DEGREE: Bachelor of Engineering (B.E.)

CONTACT: Dr. Karl B. Schnelle, Jr., Chairman
Environmental Engineering and Policy Management
Vanderbilt University
Nashville, Tennessee 37240
(615) 322-4757

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This program features a strong foundation in mathematics, basic sciences, the engineering sciences, and engineering design, and includes a choice of advanced-level studies focusing on the use of modern quantitative techniques to solve complex but practical problems in environmental resources management, pollution control, and hydraulic engineering. A joint EWRE-Chemical engineering dual major is also available in this program.

Environmental Engineering and Policy Management became identifiable as a department in 1967, and began as a program five years prior. EWRE's B.E. degree has been offered for the past five years. Since its inception, this degree has become Engineer's Council for Professional Development accredited.

This degree may lead to careers in professional engineering or may provide the foundation for further study in engineering, management, business, or law. These graduates have a design orientation in their approach to problems and are in demand by industry and consulting engineering firms.

The EWRE laboratories are fully equipped with modern equipment for chemical, physical, and biological analysis of water, wastewater, air, and solid waste. They include equipment for study of biological waste treatment, physical-chemical waste treatment, sludge conditioning and filtration, gas stripping, disinfection, air pollution, and other processes. The hydraulics laboratory includes several glass-walled flumes and tanks, temperature controls, automatic measuring and recording equipment, and other devices. All are available for student use in courses, demonstrations, and research. The computation laboratory includes a quantitative analog computer and two teletype units for access to the time-sharing digital computer system.

PROGRAM REQUIREMENTS

Admission eligibility for Vanderbilt's School of Engineering is based on the personal and academic records of the applicants. Candidates must submit academic records showing fifteen academic units (a unit representing one year's study in one subject) with evidence of intellectual ability and promise. At least four units of high school English, four units of mathematics (algebra, geometry, and trigonometry), and two of science prepare the applicant for beginning freshman level engineering courses. Desirable also are two units of a foreign language and one of history. Also required for admission committee review are scores received on the preferred SAT, or on the acceptable ACT examination. Regardless of which of those examinations is taken, all applicants must take the College Entrance Examination Board achievement tests Mathematics Level I or II and English Composition.

Generally, one hundred and twenty-seven semester hours are necessary for completion of the Bachelor of Engineering degree. During the freshman year students must take courses in chemistry, analytical geometry and calculus, elementary physics, engineering principles and resources, and a technology-society elective (EWRE 150 - Man and His Environment is recommended). Courses in economics, differential equations, chemical processes and systems, statico-dynamics, computing, special topics on the human relationship to environment in addition to the continuation of physical chemistry, analytical geometry and calculus, and physics are normally taken during the second year.

Students are expected to take charge of developing their own curricula with the guidance and consent of faculty advisors. These programs must meet the students' needs, show purpose, and display appropriate breadth and depth. A sample of such a program might include courses in fluid mechanics, water resources engineering, water and wastewater treatment, environmental chemistry, microbiology of water and wastewater, and air, public health engineering, economics and law of air and water resources, atmospheric pollution, and solid waste management.

CURRENT FACULTY, STUDENTS, GRADUATES

Including the Chairman, there are the equivalent of nine full-time faculty in this department with their primary responsibility toward instruction. There are thirty-four students enrolled in the B.E. program at the present time. During 1975 there were thirty-two and during 1976 there were forty-six. An average of eight to ten people graduate each year.

The B.E. lays an excellent foundation for advanced study, and a large percentage of the graduates do continue with graduate work. Of all graduates in this department, nearly 40 percent are employed by the Environmental Protection Agency, 25 percent by state government, 10 percent by the federal government, and another 25 percent by private industry.

PROGRAM PROJECTIONS

This department has undergone six major metamorphoses since its inception as a program. It is hoped that there will be moderate increases in enrollment. The overriding goal at this time is one of departmental stability.

COURSE DESCRIPTION

EWRE 150 Man and His Environment - Scientific and engineering principles for enhancement of quality of the total environment, with emphasis on the role of technology and its interrelationships with society. Discussions of air and water pollution; solid waste disposal; urban, rural, and regional problems; water resources and conservation; and future of humans with respect to the environment. (3 s.h.)

EWRE 151 Special Topics on Man and His Environment - Discussions of readings, and projects in selected areas of environmental concern. Students select a section based on their interest. Typical discussion sections offered include: air pollution, solid waste management; water quality in lakes, rivers and reservoirs; microbiology of pollution control; legal and social implications of environmental controls; urban problems; waste and water treatment; and other topics. (3 s.h.)

EWRE 210 Water Supply and Waste Water Collection - Hydrologic consideration of surface and ground water sources, design of distribution systems, impoundments, and control works. Hydraulics of water supply systems and sewerage works and appurtenances. Functional design of storm and sanitary sewer systems. (3 s.h.)

EWRE 211 Water and Waste Water Treatment - Water quality criteria, unit operations, and processes of water treatment. Chemical and biological characteristics of waste water; unit operations, and processes of waste water treatment; stream pollution. (3 s.h.)

EWRE 220 Environmental Problems: Air Pollution and Occupational Health - Intermediate-level consideration of subjects of air pollution and occupational health; sources of air pollution, meteorological aspects, effects, methods of measurement, and control of air pollution. Classification of occupational hazards, toxic action of industrial materials, pulmonary dust diseases, occupational dermatoses, control of particulate and gaseous agents. (1-2 s.h.)

EWRE 221 Environmental Problems: Solid Wastes and Radiological Health - Intermediate-level consideration of subjects of solid wastes and radiological health. (1-2 s.h.)

EWRE 246 Solid Waste Collection Practice - Refuse collection problems, preparation of refuse for collection, methods, equipment planning, transportations, and finance. Organization, personnel management and public relations. (2 s.h.)

EWRE 247 Municipal Refuse Disposal Practice - Quantities and composition of refuse, disposal methods and management. (2 s.h.)

EWRE 270 Public Health Engineering - Principles of public health engineering, study of vector control. (2 s.h.)

EWRE 271 Environmental Chemistry - Theoretical aspects of organic and inorganic chemistry applied to environmental engineering problems. (3 s.h.)

EWRE 272 Microbiology of Water, Waste Water, and Air - Emphasis on microbiology of air, water, sewage, and industrial wastes. (4 s.h.)

EWRE 273 Environmental Chemistry Laboratory - Chemical analysis of water and waste water and control of water purification and waste water treatment processes. (3 s.h.)

EWRE 276 Ground Water Hydrology - Occurrence and flow of ground water. Basic concepts of permeability and capillarity. (3 s.h.)

EWRE 277 Open Channel Hydraulics - Resistance in open channels. Hydraulic design of channels. Steady and unsteady non-uniform flows - characteristics and numerical solutions. (3 s.h.)

EWRE 279 Economics and Law of Air and Water Resources - Economics of air and water resource conservation and development, water rights, public policy and laws relating to air and water resources. (3 s.h.)

EWRE 280 Atmospheric Pollution - Fundamentals of atmospheric pollution and control. Sources and nature of gaseous and particulate air pollutants. (3 s.h.)

EWRE 281 Sampling and Analysis of Polluted Atmospheres - Photochemical effects and kinetics of polluted atmospheres. Modern methods of detection of air pollutants by laboratory and continuous analysis. (2 s.h.)

EWRE 295 Solid Waste Management - Solid waste management: types and quantities of wastes, collection and transportation of wastes; composting, landfills, incineration, recycling of wastes, and product recovery; resource management as a system. (3 s.h.)

INSTITUTION: VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

PROGRAM: Sanitary Engineering/Environmental Sciences and Engineering/Civil Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Paul H. King
Chairman, Environmental Sciences and Engineering
Civil Engineering Department
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061
(703) 951-6131

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental sciences and engineering/Civil engineering/ Sanitary engineering at VPI consists of five degree programs, all interrelated and designed to prepare students with a good background in several areas of environmental control. Sanitary engineering was initiated at VPI in 1945 and the environmental engineering programs established in 1968.

The environmental sciences and engineering program offers the broadest range of training, preparing students in air pollution control, water supply, and waste water. This program is designed primarily for students with undergraduate degrees in the physical or life sciences, rather than engineering. Both a Master's Degree and a Ph.D are offered in this program.

Sanitary engineering and civil engineering are water quality oriented programs and are designed for students with undergraduate degrees in engineering. Master's Degrees are offered in both Sanitary Engineering and in Civil Engineering with majors in hydraulic engineering, sanitary engineering, and water resources engineering. A Ph.D. is offered in Civil Engineering with majors in hydraulic or water resources engineering and Sanitary Engineering.

The programs are supported not only by the university but through outside funding sources such as EPA research and training grants, state environmental funds, and the federal Office of Water Research and Technology (Dept. of the Interior). In addition, the programs have their own laboratory facilities including a joint facility with the plant pathology department on effects of air pollution and a water monitoring field laboratory in Northern Virginia.

PROGRAM REQUIREMENTS

Requirements for all the M.S. programs generally include an undergraduate degree from an accredited program with an average of 2.7/4 or higher. It is preferred that students in the engineering programs have undergraduate degrees in civil, mechanical, chemical, or agricultural engineering, while environmental sciences students may have degrees in an engineering discipline or in a physical or life science.

Admission to the Ph.D. program generally requires a Master's Degree in engineering or in the case of environmental sciences, an M.S. in a physical or life science.

Degree requirements in the M.S. programs require a minimum of forty-five quarter hours, with nine to fifteen hours applied to a thesis. The engineering programs require nine credit hours in design, six in chemistry, four in microbiology, and three in analysis laboratory. The requirements in environmental science are the same except for the substitution of nine hours in the student's primary discipline in lieu of design.

The Ph.D. requirements include one hundred and thirty five quarter hours, of which between fifty and seventy may be applied to research and dissertation. Students must also demonstrate proficiency in reading one foreign language or complete an additional six credit hours in non-technical electives.

CURRENT FACULTY, STUDENTS, GRADUATES

There are seven faculty members participating in these programs, five of whom primarily teach, and two of whom are principally concerned with research. In addition, six other faculty members teach some courses in the program. The environmental sciences program draws upon faculty from other departments such as aerospace and ocean engineering, agricultural engineering, mining engineering, biology, chemistry, forestry and wildlife, and statistics.

Currently, there are fifteen full-time and three part-time students in the sanitary engineering M.S. program, fifteen full-time and two part-time in the environmental sciences M.S. program, and five in the Civil Engineering M.S. program in environmental options. There are also four students in each of the two Ph.D. programs.

Approximately sixty percent of the students come from Virginia and come to VPI through various recruiting methods such as alumni contacts, program flyers and listing in Peterson's Guide. About sixty percent of the students receive some form of financial aid which currently includes six EPA training grants, six teaching assistantships, six research assistantships, three fellowships, and four grants from the state which pay one-half salary plus tuition for employees.

Most graduates directly enter the workforce rather than continuing on to further degrees. It is estimated that about ninety percent find employment in their field, with about fifty percent going to the private sector, forty percent into government jobs, and the remainder into other positions such as teaching and research. Graduates are generally placed in positions through faculty contacts with employers.

PROGRAM PROJECTIONS

It is anticipated that current program levels will be maintained and that there is no need for expansion at this time. There is the possibility of adding one faculty member, specializing in water programs, in the next two years.

ADDITIONAL INFORMATION

Program faculty members conduct short courses each year for the Virginia State Water Control Board. This includes an operator training program each summer in which about four hundred operators receive training in preparation for state certification.

COURSE DESCRIPTION (SELECTED)

CE 4260 Introduction to Air Pollution - Scientific, engineering and legal aspects of air pollution with remedies and controls. (3 q.h.)

CE 4041, 4042, 4043 Sanitary Engineering - Processes for water purification and sewage treatment. (3 q.h.)

CE 5100 Advanced Sanitary Engineering - Principles of organic chemistry and biochemistry as applied to sanitary engineering systems. (3 q.h.)

CE 5230 Water Quality Waste Treatment - Advanced methods for research in biological and chemical treatment processes. (3 q.h.)

CE 5121 Sanitary Engineering Design - Design of treatment components and systems. (3 q.h.)

CE 5131 Public Health Engineering - Environmental sanitation, epidemiology, milk and food sanitation, solid waste disposal, industrial hygiene. (3 q.h.)

CE 5093 Air Pollution - Facilities and techniques for design of control programs for air pollution. (3 q.h.)

CE 5400 Solid Waste Practices - Current solid waste management practices. (3 q.h.)

CE 5082 Water Resources Engineering - Water resources planning, economics of water resource developments. (3 q.h.)

CE 5083 Water Resources Engineering - Design of water resources systems. (3 q.h.)

CE 6062 Advanced Engineering Hydraulics - Potential flow theory; boundary layers; turbulence; application in hydraulic design. (3 q.h.)

Stat 5090 Stochastic Modeling of Pollution: Water - Development and evaluation of stochastic models used in water pollution; dynamic regression, and stochastic models will be developed for several biodegradable processes. (3 q.h.)

Biol 5050 Environmental Science Water - Interdisciplinary seminar course in pollution assessment, waste treatment, aquatic communities, bioassays of toxicants, application factors for disposal of toxicants, problems of pollution control legislation. (2 q.h.)

Biol 5060 Water Resource Management - Seminar course, primarily for ecology and sanitary engineering, to discuss current problems and research in both fields. (2 q.h.)

Geol 4110 Ground Water Hydrology - Sources, occurrence, inventory, utilization, and recharge of ground water in the earth's crust. (3 q.h.)

Geol 4400 Environmental Geology - Applications of geologic knowledge to problems and activities associated with urban and regional development: water resources, mineral resources, waste disposal, subsurface storage, construction and physical planning. (3 q.h.)

INSTITUTION: WEST VIRGINIA UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Civil Engineering
Master of Science in Engineering

CONTACT: Dr. William J. Wilhelm, P.E.
Professor and Chairman of Civil Engineering
Civil Engineering Department
West Virginia University
Morgantown, West Virginia 26505
(304) 293-3867

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental engineering program of the Civil Engineering Department at West Virginia University was long oriented toward sanitary engineering and hydraulics. The program was constructed mainly between 1962 and 1967. In 1963 air pollution courses were incorporated and in 1967 solid waste courses were added. In 1976, the program was expanded with the addition of water resources courses. Because at the graduate level no rigid curriculum is prescribed for the degrees of Master of Science in Civil Engineering and Master of Science in Engineering, students may specialize in two or more specialty areas. Specialties are offered in air pollution control, solid waste management, water and wastewater treatment and water resources.

Students choosing to specialize in air pollution control and abatement are prepared to assume positions in local, state or federal regulatory agencies. Many students specializing in the water areas have found positions with industrial firms (eg. Union Carbide) or with consulting firms.

PROGRAM REQUIREMENTS

In order to enter Graduate School at West Virginia University, applicants with a baccalaureate degree, or its equivalent, from a department accredited by the Engineer's Council for Professional Development (ECPD) will be admitted on the same basis as engineering graduates of the University. If these requirements (ECPD) are not fulfilled, then the applicants must first fulfill the requirements of the department in which the advanced degree is sought.

For the Master of Science in Engineering degree, each candidate must fulfill a planned program conforming to one of the following (with the approval and discretion of the graduate committee):

(1) A minimum of 30 semester credits hours, not more than 6 of which are in research leading to an acceptable thesis.
(2) A minimum of 33 semester credit hours, not more than 3 of which are in research leading to an acceptable problem report.
(3) A minimum of 36 semester credit hours, with no thesis or problem report required.

A thesis or problem report is normally required of all candidates and a candidate shall be required to pass an examination which may be written, oral, or both, to be administered by the student's advisory and examining committee. Depending on the program followed, the examination covers course material and the thesis or problem report.

No rigid curriculum is required for the Master of Science in Civil Engineering and Master of Science in Engineering degrees. At least fifteen semester hours credit should normally be selected from graduate civil engineering courses. Only those holding a baccalaureate degree in civil engineering are allowed to complete the requirements for the Master of Science in Civil Engineering degree. The Master of Science in Engineering degree is available to students who enter the graduate program but do not possess a baccalaureate degree in civil engineering.

Financial assistance available to graduate students enrolled in the environmental engineering program include: U.S. EPA air pollution training grants; contract research (research assistantships); one-half time teaching fellows; National Science Foundation Coal-Energy Traineeships; and West Virginia University foundation fellowships.

CURRENT FACULTY, STUDENTS, GRADUATES

Five full-time faculty members teach the bulk of the environmental engineering courses. Assistance is provided by three adjunct professors funded through the National Institute for Occupational Safety and Health. Approximately one-half of their time is devoted to teaching and one-fourth time each devotes to research and professional activities. Current research projects they are involved with include two Department of Energy (ERDA) projects and one million dollars of state money for two projects concerning air pollution control and acid mine coal drainage control.

There are currently twenty graduate students enrolled full-time in the program and all except three are male students. There are no part-time graduate students enrolled in the program. Ten students have been graduating annually in recent years in the Master's programs. Enrollment has been rather stable over the past several years.

Few graduate students enrolled in this program continue on for additional degrees. About ninety percent find employment in their field and ten percent in a related field. Recent employment trends indicate that most graduates (75 percent) find government jobs and only 25 percent find jobs in the private sector.

PROGRAM PROJECTIONS

There is not expected to be any significant growth in this program in the next several years. Expansion primarily depends on what government research is needed in the next few years. No faculty changes are also anticipated. At West Virginia University there is an attempt to develop an Environmental Health Science Program on campus. Program officials continue to foresee environmental programs continuing to be strong as long as the federal government continues to put funds into programs through research.

COURSE DESCRIPTION (SELECTED)

146 Sanitary Engineering I - Hydrology as applied to water and waste systems. (3 s.h.)

147 Sanitary Engineering II - Examination of water and waste water, water treatment, waste water treatment and special problems in public health, air pollution, and radioactivity. (3 s.h.)

251 Public Health Engineering - Engineering aspects involved in control of the environment for the protection of health and promotion of comfort of man. (3 s.h.)

252 Water Resources Engineering - Design of water resources systems. (3 s.h.)

345 Properties of Air Pollutants - Physical, chemical, biological, and social behavioral properties of dusts, droplets, and gases in the atmosphere. (3 s.h.)

349 Solid Waste Disposal - Study of traditional patterns and problems of solid waste storage, transport, and disposal. Examination of various engineering alternatives with appropriate consideration for air and water pollution control and land reclamation. (3 s.h.)

350 Sanitary Chemistry and Biology - Theory and methods of chemical analysis of water, sewage, and industrial wastes. Biological aspects of stream pollution problems. (3 s.h.)

356 Principles of Biological Waste Treatment - Examination of biological systems used in waste treatment as to ecology and function. (3 s.h.)

446 Air Pollution Control Engineering - Study of engineering alternatives in achieving various degrees of air pollution control. (3 s.h.)

447 Air Pollution Control Standards - Comparative study of technical, economical, and social factors used in developing and establishing air pollution standards, criteria, and control limitations. (3 s.h.)

452 Water Treatment Theory - Theory of various procedures and techniques utilized in treatment of water for municipal and industrial use. (3 s.h.)

454 Industrial and Advanced Waste Treatment - Basic physical and chemical operations used in industrial and advanced waste treatment; applications for waste water reclamation and reuse; study of industrial wastes from standpoint of process, source, and treatment. (3 s.h.)

455 Municipal and Industrial Design of Solid Wastes Disposal Operations - Design criteria of existing methods and equipment for disposal of solid wastes generated by industry and municipalities: on-site preparation. (3 s.h.)

457 Hydraulics of Sanitary Engineering Works - Techniques of population growth estimation, rainfall and runoff analysis, flood flow, and ground water data to the design of sanitary works. (3 s.h.)

458 Design of Sanitary Works - Water supply and waste water disposal problems. (3 s.h.)

INSTITUTION: WESTERN KENTUCKY UNIVERSITY

PROGRAM: Environmental Engineering Technology
DEPARTMENT: Engineering Technology
DEGREE: Bachelor of Science

CONTACT: Boyce D. Tate, P.E., Head
Department of Engineering Technology
Western Kentucky University
Bowling Green, Kentucky 42101
(502) 745-2461

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Prior to the time of this program's inception (1969) a survey of industries was conducted in order to identify the skills and academic backgrounds which would make graduates valuable to industry in the field of environmental engineering technology. The results of this survey were important in the development of the curriculum.

This was the first B.S. program in environmental engineering technology to be accredited by the Engineers' Council for Professional Development. In the past such an accreditation was awarded exclusively to two-year programs. In addition to the self-study information, which was necessary for preparation of the accreditation report, the department sent questionnaires to the employers of former students to assist them in the appraisal of the effectiveness of training received at WKU.

Graduates are qualified environmental consultants, air pollution specialists, water pollution specialists, water and wastewater plant operators and, more traditionally, sanitarians.

A new building houses the well equipped environmental laboratories and part of the classrooms. This new facility is designated for environmental studies. Faculty offices and more classrooms are across the street in the engineering building.

PROGRAM REQUIREMENTS

Graduates of Kentucky high schools are unconditionally admitted to the freshman class, while out-of-state applicants must rank in the top half of their graduating class, have a 2.0 average in a college preparatory program, and have satisfactory ACT scores.

Students must complete six semester credits of English, eleven credits of mathematics, three credits of computer science, twelve of chemistry, eight of physics, seven of biology, three of economics, three of industrial education, three of geology. General studies electives account for twenty-seven credits and the major requirement consists of forty-nine hours of engineering technology and environmental engineering technology. The entire program requires one hundred and thirty-two semester hours for graduation with the B.S. degree.

CURRENT FACULTY, STUDENTS, GRADUATES

Two full-time faculty members coordinate both this program and one entitled Environmental Science (also in the Department of Engineering Technology). Seven other faculty members from other areas of engineering provide part-time support by teaching courses. Faculty growth often occurs through the hiring of persons with expertise in both environmental engineering technology and one other engineering discipline, the result being a joint appointment.

There are forty students currently enrolled in this option. Many of the students have transferred from junior colleges upon completion of an associate degree. Eight students will graduate in June, 1978.

Because employers are not always aware of the nature of the skills these graduates possess, they are slow to hire them. Eventually, all graduates from past classes have found related placements, but not without first taking considerable initiative. Follow-up data show 42 percent seek advanced degrees, 37 percent are employed in private engineering and consulting firms, and 43 percent are working in government positions.

PROGRAM PROJECTIONS

In the near future a coop arrangement will begin. It is felt that this work experience will greatly enhance the hireability of graduates.

Plans for tracks within this option are gelling. Soon students will be able to specialize in water and wastewater engineering technology. Later, tracks in air pollution management, solid waste management, industrial hygiene, and radiation protection will be offered.

COURSE DESCRIPTION

ET 280 Introduction to Environmental Studies - Introduction to the basic concepts and language of population, air pollution, water pollution, environmental radiation, solid waste, disposal and other environmental problems. (3 s.h.)

ET 360 Air Pollution Control - Sources, effects, air quality criteria and standards, monitoring and control of air contaminants. (3 s.h.)

ET 475 Air Pollution Control Lab - Monitoring for particulates and gaseous contaminants: settleable and suspended particulates and gases (SO_2, NO, NO_2, O_x, CO). (1 s.h.)

ET 410 Water Supply - Design of collection, purification, and water distribution facilities. (3 s.h.)

ET 415 Water Supply Lab - Monitoring for physical, chemical and biological characteristics of a water supply as well as field trips to water treatment plants. (1 s.h.)

ET 420 Wastwater Treatment - Design of collection, treatment and disposal systems for wastewater. (3 s.h.)

ET 425 Wastewater Lab - Unit processes and unit operations for aerobic and anaerobic systems coupled with monitoring for the significant operating parameters. (1 s.h.)

ET 430 Radiological Health - Fundamentals of atomic, nuclear and radiation physics as related to radiological health. (3 s.h.)

ET 475 Radiological Health Lab - Fundamentals of detection of ionizing radiation, including X and gamma radiations, alpha and beta particles. (1 s.h.)

ET 440 Industrial Hygiene - Fundamental principles of occupational health and emphasizes recognition, evaluation and control of occupational health hazards. (3 s.h.)

ET 470 Industrial Waste Treatment - Design-orientation for the application of preliminary, primary, secondary, and advanced water treatment processes for industrial discharge. (3 s.h.)

ET 480 Solid Waste Treatment - Practice and technology of solid waste collection and disposal, including sanitary landfill, incineration, composting, recycling and recent developments. (3 s.h.)

ET 490 Sanitation - Sanitary principles involved in the production and processing of milk, milk products, and food, including sanitary codes and inspection procedures. Swimming pools and housing included. (3 s.h.)

ET 495 Environmental Impact Statement - An understanding of procedure and details in preparation and review of environmental impact statements. (3 s.h.)

INSTITUTION: WESTERN KENTUCKY UNIVERSITY

PROGRAM: Environmental Science

DEPARTMENT: Engineering Technology

DEGREE: Bachelor of Science

CONTACT: Boyce D. Tate, Head
Department of Engineering Technology
Western Kentucky University
Bowling Green, Kentucky 42101
(502) 745-2461

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental Science was conceptualized and formally approved during the fall of the 1973-1974 academic year. It replaces the previous Environmental Health program, and was developed as a companion to the Environmental Engineering Technology program. The curriculum is sufficiently flexible as to allow the opportunity to pursue a number of interests in the environmental area including air pollution, water pollution, radiation protection, occupational health and others.

A new building, which is designated specifically for environmental studies, houses well-equipped environmental laboratories and several of the classrooms. Faculty offices and the remainder of the classrooms are located across the street in the engineering building.

Graduates are qualified environmental specialists with expertise in occupational health, radiation protection, air pollution, water pollution, and environmental assessments (i.e., environmental impact statements). In part, the reason for the change from Environmental Health to Environmental Science was a function of graduates having no placement opportunities except as sanitarians; the current program provides greater occupational diversity.

PROGRAM REQUIREMENTS

Graduates of Kentucky high schools are unconditionally admitted to the freshman class, while out-of-state applicants must rank in the top half of their graduating class, have a 2.0 average in a college preparatory program, and have a satisfactory ACT score.

The Environmental Science curriculum includes an area of concentration consisting of fifty-two/fifty-three semester hours in the student's specialty field and is formulated around four course groupings. The first core is composed of thirty-nine/forty hours of humanities, social and behavioral studies, physical development, and organization and communication of ideas. Thirty-seven hours of basic sciences serve as the principle group of prerequisite courses for the specialty area and provide a foundation in traditional science areas.

The principal problem areas of the environmental field are included in the environmental area core, emphasizing the aspects of evaluation and control of the various environmental hazards. A strong laboratory orientation is an important feature of this option, and it provides direct experience with the parameters and measurements important in the various areas. Twenty-seven to twenty-eight credits dealing with air pollution, water pollution, sanitation, solid wastes, industrial hygiene, radiological health, and environmental impact assessments compose this segment of the curriculum.

The final core (twenty-seven to twenty-nine semester hours) provides the flexibility which permits students to outline their own track, or specialty. The approved electives are intended to allow a student who is interested in a particular environmental topic area to select courses from other science areas that lend support to his/her interest.

CURRENT FACULTY, STUDENTS, GRADUATES

Two full-time faculty coordinate both this program and its companion, Environmental Engineering Technology. Part-time teaching support comes from the seven full-time faculty in the various other disciplines of the Department of Engineering Technology.

Although the enrollment has demonstrated a steady increase from the initial twelve students to the current thirty-seven, it is still felt that recruitment efforts need to be made. Seven people graduated in 1977. There has been a total of nineteen graduates in this option.

While there has been no formal follow-up survey conducted, personal contact has located all but one of the former students. Forty-two percent have continued their educations in advanced degree programs, 37 percent found positions in private companies (predominantly consulting firms), and 21 percent were employed by the government.

PROGRAM PROJECTIONS

Shortly, two tracks will be considered, one in industrial hygiene and the other in radiation protection. Additional faculty would be desirable, but the expertise to begin each of these tracks at the current staffing level does exist.

The realization of such options relies heavily on the continued growth of student enrollment and on eventually securing new faculty, the most critical determinant being the enrollment increase. There is now a substantial recruitment effort taking place.

COURSE DESCRIPTION

ET 107 Introduction to Engineering Technology - Introduction to the various specialties in engineering technology, careers and opportunities. Reviews technical competence expected of engineering technicians and technologists. (1 s.h.)

ET 280 Introduction to Environmental Studies - Physical, chemical and biological parameters of the environment. Basic concepts and language of population, air pollution, water pollution, environmental radiation, solid waste disposal and other environmental topics. (3 s.h.)

ET 360 Air Pollution Control - Demonstration of basic air pollution monitoring equipment. Air pollution sources, nature and behavior of air pollutants, air sampling and analysis, dispersion and diffusion in the atmosphere, the effects of weather on air pollution, air pollution surveys, physiological effects, and methods and equipment for community air pollution control. (3 s.h.)

ET 410 Water Supply - Planning, operation and design of water supply systems. Water consumption and supply, water quality standards and criteria, population predictions, hydrological considerations of surface and ground water. Design of collection, purification and water distribution systems. Testing procedures for water quality surveys and water treatment plant operation. (3 s.h.)

ET 415 Water Supply Laboratory - Laboratory course correlated with ET 410. (1 s.h.)

ET 420 Waste Water Treatment - Theory, design and operation of waste water collection and disposal systems, considered as unit operations and unit processes. Functional design of storm and sanitary sewers, sewage works and appurtenances. Chemical and biological characteristics of waste water. (3 s.h.)

ET 425 Waste Water Treatment Laboratory - Laboratory course correlated with ET 420. (1 s.h.)

ET 430 Radiological Health - Fundamentals of atomic, nuclear and radiation physics as related to radiological health. Fundamentals of detection of ionizing radiation, including X and gamma radiations, alpha and beta particles and neutrons. Counting techniques, statistics, radiation interaction, biological effects, radiation hazards (maximum permissible concentration and dose) and radioactive waste disposal. (3 s.h.)

ET 435 Radiological Health Laboratory - A laboratory course correlated with ET 430. (1 s.h.)

ET 440 Industrial Hygiene - Fundamental principles of occupational health and the recognition, evaluation and control of occupational health hazards. Occupational Safety and Health Act of 1970. Industrial health hazards. Reaction of respiratory system to

ET 440 (Cont'd) - particulates and gases. Mode of action of organic and inorganic chemicals such as lead and mercury. Pneumoconiosis. Noise measurement and control. Evaluation of heat stress. Electromagnetic spectrum. Ionizing radiation. Industrial ventilation. Instrumental methods such as x-ray diffraction, gas chromatography and atomic absorption. (3 s.h.)

ET 470 Industrial Waste Treatment - Studies of the characteristics and composition of wastes from industrial processes and their effects on the environment. Methods of sampling and analysis of industrial waste and remedial measures for treatment and disposal. (3 s.h.)

ET 480 Solid Waste Treatment - Extent and characteristics of the solid waste problem. Current practice and new developments in management of solid waste. Physical and chemical composition of refuse disposal, collection methods and disposal methods such as sanitary landfill, incineration, composting, salvage and reclamation. Public health significance of solid waste management. (3 s.h.)

ET 495 Environmental Impact Statements - Preparation of assessments of environmental impacts as outlined by the National Environmental Policy Act (NEPA). (3 s.h.)

INSTITUTION: YALE UNIVERSITY

PROGRAM: Environmental Health

DEPARTMENT: Epidemiology and Public Health

DEGREE: Master of Public Health

CONTACT: Jan Adrianus Jozef Stolwijk, Ph.D.
Professor of Epidemiology (Environmental Health)
Yale University, School of Public Health
Department of Epidemiology and Public Health
60 College Street
New Haven, Connecticut 06510
(203) 562-9901

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The John B. Pierce Laboratory has been affiliated with Yale University since its founding in 1924. Many of the Laboratory's staff hold joint appointments at the University, primarily in the Department of Epidemiology and Public Health. The Pierce Laboratory now conducts a major portion of Yale's program in environmental health. The Laboratory's staff of physiologists, psychologists, and engineers are well known internationally for their studies of how humans respond to the environment, particularly the thermal environment. They also conduct research in air sanitation, thermal physiology, and the mechanisms of related adverse health effects.

Epidemiological and toxicological studies are also conducted by laboratory staff in order to describe and accurately assess the effect of air pollutants on human health, in the occupational and community environment. An ongoing air sanitation research program is concerned with the measurement of acute adverse effects of air pollutants in the New Haven area. Recent research has found that when combined with the blood's capacity to transport oxygen to the body's tissues. The air sanitation laboratory has devices and tools for studies of human responses to air pollution. Air sanitation laboratory staff study the pulmonary function and resistance changes in man and animals resulting from breathing noxious materials and gases.

Yale University's Division of Environmental Health, started in 1967, is concerned with the study and management and control of natural and human caused factors in the environment in their relationship to human health and well-being. Emphasis in the program is placed on providing the students a broad and sound understanding of the source and characteristics of environmental factors and the mechanism of their interaction with people.

Students who participate in the Division of Environmental Health's programs are prepared for employment by governmental and service agencies and by industry. Environmental health graduates are expected to be able to participate in and/or direct the environmental health activities and operations of a governmental, service, or industrial organization. Many graduates become directors of health districts, environmental coordinators of state health departments,sanitarians, and other administrative positions. Governmental administrative positions often are in environmental and occupational health capacities. Others find positions in unions, industry, consulting (research and teaching) and with organizations such as the Environmental Defense Fund and the American Lung Associates.

PROGRAM REQUIREMENTS

The Department of Epidemiology of Public Health requires candidates for the Master of Public Health to possess, in order to be admitted, either: (1) a graduate degree, from an acceptable institution, in a discipline relevant to public health, or (2) a bachelor's degree from an acceptable institution, with a substantial knowledge in a discipline relevant to public health either through study or experience or a combination of these. Candidates are expected to have attained an undergraduate average of B.

Students who have not had prior course work in human physiology will be expected to take Epidemiology and Public Health 111A, The Human Body in Health and Disease. All students are expected to attend the weekly seminar in environmental physiology. For graduation, all students are expected to earn satisfactorily a minimum of sixty credits, including four credits for supervised field training and nine credits for the essay.

The Division of Environmental Health's eleven required courses provide an understanding of the basic interactions between people and their environment as well as an introduction to the control and management techniques. Elective courses give students opportunities to specialize in a selected area of environmental health.
The Division's curriculum is sufficiently flexible to accomplish this. Some students may specialize in the application of control and management techniques, particularly those methods pertaining to the engineering and sanitation aspects of the environment. Research work performed in conjunction with Environmental Health 213 Research in Environmental Health, provides study opportunities to do an in-depth study in a selected area of environmental health. Some of the advanced or specialized courses are taught on a tutorial or semi-tutorial basis with the program of instruction being geared to meet the student's specific needs or interests. Students are also encouraged in the program to elect appropriate courses in other departments and schools of Yale University.

A three month summer practicum is available to students in the program between the first and second years. It affords students an opportunity to obtain "hands on" experience and bring the training gained back to class to share. Students have been sponsored by the EPA, state and local health departments, television and newspaper media and the State of New York. Also, during the second year, students participate in a one day per week practical work experience. In this they are assigned to an employed environmental health person one day a week at local or state health departments. Then they write an essay examining an environmental health problem.

The Department of Epidemiology and Public Health is a participant in the Graduate and Professional School Financial Aid Service and loans and grants are awarded on the basis of need. Two pre-doctoral and two post-doctoral fellowships are available to students in the program and the National Institutes of Health are the funding source. A number of partial traineeships are also available from the Federal government for Master's students.

CURRENT FACULTY, STUDENTS, GRADUATES

Ten faculty members contribute to the teaching and research conducted by the Division of Environmental Health. It is estimated that about 25% of their time is devoted to teaching and 75% to research. All ten are entirely supported by research funding from the National Institutes of Health, the National Science Foundation, the National Aeronautics and Space Administration, the Air Force, the American Society for Health and Engineering and the General Foods Corporation. The National Institute for Environmental Health Science funds a grant for the Division's training program.

A total of twenty students (50% female) are currently enrolled full-time. There are no part-time students enrolled in the Division's program. Ten students annually receive the Master of Public Health degree, on the average. The number of graduates and enrollment have remained stable.

This program is designed to be a terminal program as only the Master's degree is offered. Some students do continue for doctorates, M.D.s and law degrees, however. Most that continue for doctorates do so at schools which have environmental physiology or environmental health programs. Virtually all graduates obtain employment in their field, and it is estimated that one-half enter positions in the private sector and the other one-half find jobs in the public sector. Most obtain occupational health positions.

PROGRAM PROJECTIONS

Although this program is not expected to significantly change in faculty staff size, enrollment, or emphasis, additional continuing education package programs are likely to be developed. These programs will be designed for people already working in the field.

Additional administrative occupational health personnel will probably be recruited to teach community and occupational health courses. These personnel may already have positions as a director of a medical corporation, for example. Additional degree programs will not be developed because doctorates are already offered in the fields of epidemiology, and environmental biostatistics.

Professionals in the field foresee a slow and steady growth in the environmental health field. The new Toxic Substances Control Act requires an enormous need for testing in stages. They feel that this program would work better if expanded because research results could be obtained if the program is doubled. Even if the program was doubled, Yale professionals in the program do not feel that the market would be flooded in the environmental health field.

COURSE DESCRIPTION

100b Introduction to Air Pollution - Principal sources and causes of air pollution, the nature and behavior of air pollutants, the effects of air pollution, and the organization and administration of control measures. (1 s.h. first half term)

112a Water Supply and Waste Water Treatment - A study of the design and operation of water supply systems and waste water treatment systems. (2 s.h.)

113b Solid Waste Management - Consideration of the fundamentals of solid waste collection, storage, processing, and disposal. (1 s.h.)

120a Principles of Radiological Health - Basic problems and programs of environmental and occupational control of ionizing radiation. (1 s.h.)

150b Introduction to Environmental Control - A survey course in environmental control which identifies the various environmental entitities that affect or may affect health and discusses the various methods of control. (2 s.h.)

151 Seminar in Environmental Control and Management - Students and guest lecturers discuss current problems of environmental control and management. (1 s.h. each term)

153b Environmental Control in Community Hygiene I - Subject matter includes air pollution, solid waste, housing and vector control. (4 s.h.)

154a Environmental Control in Community Hygiene II - Subject matter includes water supply and waste water treatment, food and milk sanitation, ionizing radiation. (4 s.h.)

155 Readings in Environmental Health - Study and review of the literature in selected areas of environmental health with particular emphasis upon research and epidemiological studies. (2-4 s.h. each term)

Photo reprinted from the Michigan Technological University Catalog 1975-76

APPENDICES

Photo reprinted from the University of Illinois Institute of Technology Booklet

Photo reprinted from the Indiana University of Public and Environmental Affairs Catalog 1977-78

APPENDIX I

DEGREE ABBREVIATIONS

APPENDIX I

Degree Abbreviations

A.A.	Associate of Arts
A.A.Ag.	Associate of (in) Applied Agriculture
A.Ag.	Associate of (in) Agriculture
A.A.P.C.T.	Associate Degree in Air Pollution Control Technology
A.A.S.	Associate of Applied Science
A.B.	Bachelor of Arts
A.D.	Associate Degree
A.E.T.	Associate in Engineering Technology
A.M.T.	Associate of Mining Technology
A.N.E.T.	Associate of Nuclear Engineering Technology
A.S.	Associate in Science
A.S.E.M.T.	Associate of Science in Engineering Mining Technology
A.T.	Associate of Technology
B.A.	Bachelor of Arts
B.E.M.T.	Bachelor of Engineering in Mining Technology
B.S.	Bachelor of Science
B.S. (N.E.)	Bachelor of Science in Nuclear Engineering
B.S. (N.E.S.)	Bachelor of Science (Nuclear Engineering Sciences)
B.S. (N.R.)	Bachelor of Science in Natural Resources
B.S.A.	Bachelor of Science in Agriculture
B.S.C.E.	Bachelor of Science in Civil Engineering
B.S.Ch.E.	Bachelor of Science in Chemical Engineering
B.S.E.	Bachelor of Science in Engineering
B.S.E.H.	Bachelor of Science in Environmental Health
B.S.E. (N.E.)	Bachelor of Science (Nuclear Engineering)
B.S.E.S.	Bachelor of Science in Engineering Sciences
B.S.N.E.	Bachelor of Science in Nuclear Engineering
B.T.	Bachelor of Technology
Cert.	Certificate

D.E.	Doctor of Engineering
D.P.H.	Doctor of Public Health
D.S.	Doctor of Science
D.S. (Hyg.)	Doctor of Science Hygiene
D.Sc.	Doctor of Science
Dr.P.H.	Doctor of Public Health

E.E.	Environmental Engineer
Eng.	Engineer
Engr.	Engineer
Engr.Sc.D.	Doctor of Engineering Science
Env.E.	Environmental Engineer
Envir.Eng.	Environmental Engineer

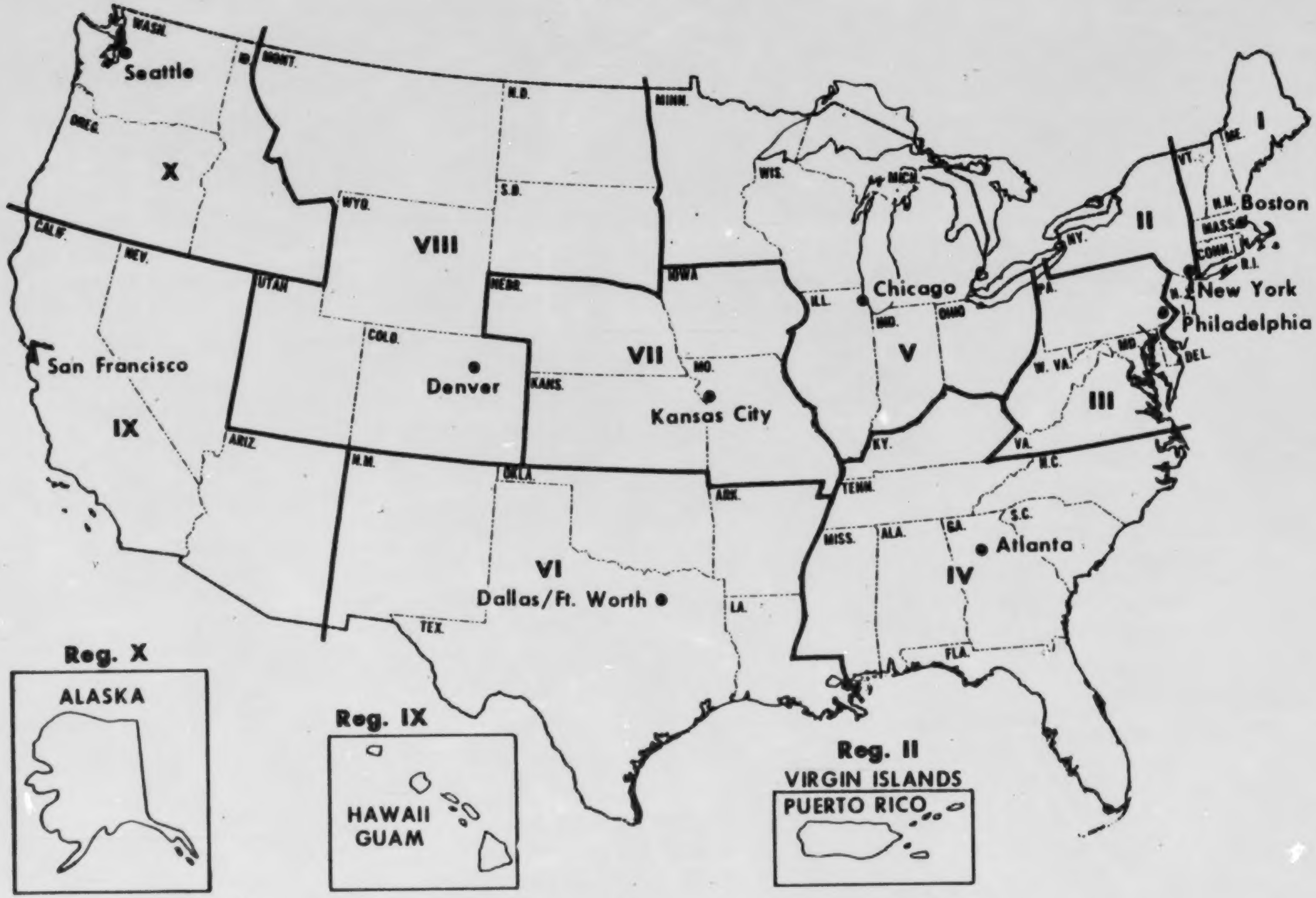
M.A.	Master of Arts
M.Ag.	Master of Agriculture
M.Agr.	Master of Agriculture
M.A.S.	Master of Applied Science
M.C.E.	Master of Civil Engineering
M.E.	Master of Engineering
M.E.E.E.	Master of Engineering in Environmental Engineering
M.E.A.S.	Master of Environmental Arts and Science
M.E.H.S.	Master of Environmental Health Sciences
M.E.M.	Master of Environmental Management
M.E.P.C.	Master in Environmental Pollution Control
M.Eng.	Master of Engineering
M.Engr.	Master of Engineering
M.F.	Master of Forestry
M.M.E.	Master of Mechanical Engineering
M.P.	Master of Philosophy
M.P.A.	Master of Public Affairs
M.P.H.	Master of Public Health
M.P.P.P.M.	Master of Plant Protection and Pest Management

M.P.S.	Master of Professional Studies
M.S.	Master of Science
M.S. (Hyg.)	Master of Science Hygiene
M.S.C.E.	Master of Science in Civil Engineering
M.S.Ch.E.	Master of Science in Chemical Engineering
M.S.E.	Master of Science in Engineering
M.S.E.E.	Master of Science in Environmental Engineering
M.S.En.E.	Master of Science in Environmental Engineering
M.S.Eng. S.	Master of Science in Environmental Engineering
M.S.Eng. Sci.	Master of Science in Engineering Science
M.S.E.H.	Master of Science in Environmental Health
M.S.E.M.P.	Master of Science in Energy Management and Policy
M.S.E.S.	Master of Science in Environmental Science (Studies)
M.S.P.H.	Master of Science in Public Health
M.S.(S.E.)	Master of Science in Sanitary Engineering
M.S.(S.S.)	Master of Science in Sanitary Science
N.E.	Nuclear Engineering
Nuc. Eng.	Nuclear Engineering
Ph.D.	Doctor of Philosophy
S.B.	Bachelor of Science
Sc.D.	Doctor of Science
S.M.	Master of Science

APPENDIX II

TERMINOLOGY

STANDARD REGIONAL BOUNDARIES
TEN REGIONS


WASH.
Seattle
ID.
MONT.
OREG.
X
N.D.
MINN.
S.D.
WYO.
VIII
CALIF.
NEV.
UTAH
NEBR.
IOWA
COLO.
Denver
KANS.
VII
MO.
Kansas City
San Francisco
IX
ARIZ.
N.M.
OKLA.
ARK.
VI
Dallas/Ft. Worth
TEX.
LA.
WIS.
MICH.
ILL.
Chicago
IND.
OHIO
V
KY.
TENN.
MISS.
ALA.
GA.
S.C.
N.C.
Atlanta
IV
FLA.
ME.
I
VT.
N.H.
Boston
MASS.
CONN.
R.I.
N.Y.
II
N.J.
New York
PA.
Philadelphia
MD.
DEL.
W. VA.
VA.
III
Reg. X
ALASKA
Reg. IX
HAWAII
GUAM
Reg. II
VIRGIN ISLANDS
PUERTO RICO

TERMINOLOGY

ACT (American College Testing) and SAT (Scholastic Aptitude Test) - Standardized examinations which are intended to provide applicants and institutions with a numerical statement of an individual's ability and readiness to successfully complete college/university level work.

Co-op program - A plan whereby a student receives financial assistance and academic credit under the direction of a cooperating employment site representative and a faculty advisor in exchange for an agreed upon condition of employment. Students must complete all degree requirements as per the norm.

Course - For the purpose of this study, a course is considered a unit of a program, in which a body of knowledge is presented, the satisfactory completion of which leads to the awarding of a predetermined or individually arranged number of credits.

ECPD (Engineers' Council for Professional Development) - Accrediting body for programs in engineering technology.

ERIC (Educational Resources Information Center) - A national information system designed and developed by the U.S. Office of Education, and now supported and operated by the National Institute of Education (NIE), for providing ready access to descriptions of exemplary programs, research and development efforts, and related information that can be used in developing more effective educational programs.

GRE (Graduate Record Examination) - (General Aptitude) An examination of verbal and mathematical competency and aptitude, which is designed to provide a numerical indication of an individual's ability to successfully complete advanced level work. For the purposes of the study, the GRE will not refer to the Advanced Examinations.

Internship/Applied Study Term - An arrangement which is intended to provide a simulation of work experience under the direction of academic advisors and is designed to be an integral segment of an individual's academic program. (College credit may be given.)

IRIS (Instructional Resources Information System) - A computerized information base listing materials relating to education and training in the water quality control field, which is located in the National Training and Operational Technology Center of the U.S. Environmental Protection Agency.

MEDLINE - Computerized literature search services with application to medical information.

NTIS (National Technical Information Service) - Computerized literature search services.

Program - For the purpose of this study, a plan of study, either completely prescribed, or containing options, with an identity of its own, and standard rules and procedures, the satisfaction of which may lead to a degree, certificate, or diploma.

Quarter hours - vs. - Semester hours - One semester hour is the credit equivalent to one and a half quarter hours.

Standard Federal Boundaries - Geographic division of the United States for the purposes of decentralized administration; in this report also referred to as EPA regions (see map on preceding page).

TOXLINE - Computerized literature search services with particular application to the recall of information concerning toxic substances.

WRSIC (Water Resources Scientific Information Center) - Collects, screens, organizes and disseminates reports in water resources.

APPENDIX III

SELECTED BIBLIOGRAPHY

SELECTED BIBLIOGRAPHY

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APPENDIX IV

PARTICIPATING INSTITUTIONS
BY
ENVIRONMENTAL CATEGORY

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
AIR	Carnegie-Mellon University	Pittsburgh, PA
	Clemson University	Clemson, SC
	Drexel University	Philadelphia, PA
	George Washington University-NASA	Hampton, VA
	Harvard University School of Public Health	Boston, MA
	Hudson Valley Community College	Troy, NY
	Massachusetts Institute of Technology	Ithaca, NY
	Michigan Technological University	Houghton, MI
	Middlesex County College	Edison, NJ
	Muskingum Area Technical College	Zanesville, OH
	New Jersey Institute of Technology	Newark, NJ
	North Carolina State University	Chapel Hill, NC
	North Dakota State School of Science	Wahpeton, ND
	Northeastern University	Boston, MA
	Ohio State University	Columbus, OH
	Portland State University	Portland, OR
	Prairie State Community College	Chicago Heights, IL
	Purdue University	West Layfayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Rutgers-The State University of New Jersey	New Brunswick, NJ
	Springfield Technical Community College	Springfield, MA
	Stevens Institute of Technology	Hoboken, NJ
	Sumter University	Sumter, SC
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	The Pennsylvania State University	University Park, PA
	University of Cincinnati	Cincinnati, OH
	University of Delaware	Newark, DE
	University of Florida	Gainesville, FL
	University of Iowa	Iowa City, IA
	University of Kentucky	Lexington, KY
	University of Maryland	College Park, MD
	University of Michigan	Ann Arbor, MI
	University of Missouri-Rolla	Rolla, MO
	University of North Carolina	Chapel Hill, NC
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
	University of Texas-Austin	Austin, TX
	University of Washington	Seattle, WA
	University of Wisconsin-Milwaukee	Milwaukee, WI
	Vanderbilt University	Nashville, TN
	Washington State University	Pullman, WA
	Washington University	St. Louis, MO
	West Virginia University	Morgantown, WV
	Yale University	New Haven, CT

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
COMPOSITE:	Antioch College	Yellow Springs, OH
	Baylor University	Waco, TX
	Bemidji State University	Bemidji, MN
	California Institute of Technology	Pasadena, CA
	California Polytechnic State University	San Luis Obispo, CA
	Catholic University of America	Washington, DC
	Carnegie-Mellon University	Pittsburgh, PA
	Chattanooga State Technical Community College	Chattanooga, TN
	Clarkson College	Potsdam, NY
	Clemson University	Clemson, SC
	Cornell University	Ithaca, NY
	Delaware Technical and Community College	Newark, DE
	Delgado College	New Orleans, LA
	Drexel University	Philadelphia, PA
	Duke University	Durham, NC
	East Central Oklahoma State University	Ada, OK
	East Tennessee State University	Johnson City, TN
	Evergreen State College	Olympia, WA
	Ferris State College	Big Rapids, MI
	Florida International University	Miami, FL
	Georgia Institute of Technology	Atlanta, GA
	Heed University	Hollywood, FL
	Hocking Technical College	Nelsonville, OH
	Howard University	Washington, DC
	Hunter College	New York, NY
	Indiana University	Bloomington, IN
	Iowa State University	Ames, IA
	Johns Hopkins University	Baltimore, MD
	Kansas State University	Manhattan, KS
	Kirkwood Community College	Cedar Rapids, IA
	Lamar University	Beaumont, TX
	Macalester College	St. Paul, MN
	Massachusetts Institute of Technology	Cambridge, MA
	McNeese State University	Lake Charles, LA
	Miami University	Oxford, OH
	Michigan State University	East Lansing, MI
	Middle Tennessee State University	Murfreesboro, TN
	Morehead State University	Morehead, KY
	Muskingum Area Technical College	Zanesville, OH
	New Jersey Institute of Technology	Newark, NJ
	North Carolina State University	Raleigh, NC
	Northland College	Ashland, WI
	Ohio State University	Columbus, OH

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
COMPOSITE: (Cont'd)	Ohio University	Athens, OH
	Oscar Rose Junior College	Midwest City, OK
	OSU Oklahoma City Technical Institute	Oklahoma City, OK
	Polytechnical Institute of New York	Brooklyn, NY
	Princeton University	Princeton, NJ
	Purdue University	West Lafayette, IN
	Raymond Walters General and Technical College (University of Cincinnati	Cincinnati, OH
	Rensselaer Polytechnical Institute	Troy, NY
	Rutgers University	New Brunswick, NJ
	Sam Houston State University	Huntsville, TX
	Sangamon State University	Springfield, IL
	Slippery Rock State College	Slippery Rock, PA
	Springfield Technical and Community College	Springfield, MA
	Stevens Institute of Technology	Hoboken, NJ
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	Texas A & M University	College Station, TX
	The Cooper Union	New York, NY
	The Pennsylvania State University	University Park, PA
	University of Alabama	University, AL
	University of Alaska	Fairbanks, AK
	University of Arkansas	Fayetteville, AR
	University of California-Santa Barbara	Santa Barbara, CA
	University of Cincinnati	Cincinnati, OH
	University of Delaware	Newark, DE
	University of Florida	Gainesville, FL
	University of Georgia	Athens, GA
	University of Kansas	Lawrence, KS
	University of Louisville	Louisville, KY
	University of Maine-Orono	Orono, Maine
	University of Michigan	Ann Arbor, MI
	University of Minnesota	Minneapolis, MN
	University of North Carolina	Chapel Hill, NC
	University of Oklahoma	Norman, OK
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
	University of Toledo	Toledo, OH
	University of Utah	Salt Lake City, UT
	University of Washington	Seattle, WA
	University of Wisconsin-Green Bay	Green Bay, WI
	University of Wisconsin-Madison	Madison, WI
	Utah State University	Logan, UT

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
COMPOSITE: (Cont'd)	Vanderbilt University	Nashville, TN
	Virginia Polytechnic Institute and State University	Blacksburg, VA
	Washington State University	Pullman, WA
	Western Kentucky University	Bowling Green, KY
	Western Washington University (Huxley College of Environmental Studies)	Bellingham, WA
	West Virginia University	Morgantown, WV
	Yale University	New Haven, CT
ENERGY:	Bluefield State College	Bluefield, WV
	Brigham Young University	Provo, UT
	Carnegie-Mellon University	Pittsburgh, PA
	Columbia University	New York, NY
	Cornell University	New York, NY
	Georgia Institute of Technology	Atlanta, GA
	Hartford State Technical College	Hartford, CT
	Kansas State University	Manhattan, KS
	Lamar University	Beaumont, TX
	Massachusetts Institute of Technology	Cambridge, MA
	Morehead State University	Morehead, KY
	Muskingum Area Technical College	Zanesville, OH
	Oregon State University	Corvallis, OR
	Pikeville College	Pikeville, KY
	Polytechnic Institute of New York	Brooklyn, NY
	Princeton University	Princeton, NJ
	Purdue University	West Lafayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Southern Technical Institute	Marietta, GA
	Texas State Technical Institute	Waco, TX
	The Pennsylvania State University	University Park, PA
	University of California-Berkeley	Berkeley, CA
	University of Florida	Gainesville, FL
	University of Kentucky	Lexington, KY
	University of New Mexico	Albuquerque, NM
	University of Pennsylvania	Philadelphia, PA
	University of Tennessee	Knoxville, TN
	West Virginia Institute of Technology	Montgomery, WV
	West Virginia University	Morgantown, WV

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
NOISE:	George Washington University-NASA	Hampton, VA
	Georgia Institute of Technology	Altanta, GA
	Massachusetts Institute of Technology	Cambridge, MA
	Memphis State University	Memphis, TN
	North Carolina State University	Raleigh, NC
	The Pennsylvania State University	University Park, PA
	University of Cincinnati	Cincinnati, OH
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
	University of Tennessee Center for Health Sciences	Memphis, TN
PESTICIDES:	Abraham Baldwin Agricultural College	Tifton, GA
	Broward Community College	Ft. Lauderdale, FL
	Central Technical Community College	Hastings, NE
	Delgado Community College	New Orleans, LA
	Harvard University School of Public Health	Boston, MA
	Mississippi State University	Mississippi State, MS
	New Mexico State University	Las Cruces, NM
	North Carolina State University	Raleigh, NC
	Ohio State University	Columbus, OH
	Oregon State University	Corvallis, OR
	Rutgers State University of New Jersey	New Brunswick, NJ
	State University of New York at Farmingdale	Farmingdale, NY
	Texas A & M University	College Station, TX
	The Pennsylvania State University	University Park, PA
	University of California-Berkeley	Berkeley, CA
	University of California-Davis	Davis, CA
	University of California-Riverside	Riverside, CA
	University of Cincinnati	Cincinnati, OH
	University of Delaware	Newark, DE
	University of Georgia	Athens, GA
	University of Iowa	Iowa City, IA
	University of Maryland	College Park, MD
	University of New Hampshire	Durham, NH
	University of Pittsburgh	Pittsburgh, PA
	University of Rochester	Rochester, NY
	Utah State University	Logan, UT

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
POTABLE WATER:	Atlanta University Center/Georgia Institute of Technology	Atlanta, GA
	Brigham Young University	Provo, UT
	California State University	Sacramento, CA
	Carnegie-Mellon University	Pittsburgh, PA
	Casper College	Casper, WY
	Central Technical Community College	Hastings, NE
	Clarkson College	Potsdam, NY
	Clemson University	Clemson, SC
	Colorado State University	Fort Collins, CO
	Community College of Denver-Red Rocks	Golden, CO
	Cornell University	Ithaca, NY
	Delgado College	New Orleans, LA
	Drexel University	Philadelphia, PA
	East Maine Vocational Technical Institute	Bangor, ME
	Hudson Valley Community College	Troy, NY
	Illinois Institute of Technology	Chicago, IL
	Iowa State University	Ames, IA
	J. Sargeant Reynolds Community College	Richmond, VA
	Kansas State University	Manhattan, KS
	Kirkwood Community College	Cedar Rapids, IA
	Linn-Benton Community College	Albany, OR
	Manhattan College	New York, NY
	Marquette University	Milwaukee, WI
	Massachusetts Institute of Technology	Cambridge, MA
	Miami-Dade Community College	Miami, FL
	Michigan Technological University	Houghton, MI
	Middlesex Community College	Edison, NJ
	Missouri Southern State College	Joplin, MO
	Montana State University	Bozeman, MT
	Muskingum Area Technical College	Zanesville, OH
	Northeastern University	Boston, MA
	Northern Montana College	Havre, MT
	Ohio State University	Columbus, OH
	Operator Training Center	Murfreesboro, TN
	Oregon Institute of Technology	Klamath Falls, OR
	Oscar Rose Junior College	Midwest City, OK
	Purdue University	West Lafayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Rice University	Houston, TX
	Rochester Institute of Technology	Rochester, NY
	Rutgers State University of New Jersey	New Brunswick, NJ
	Southern Illinois University	Edwardsville, IL

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
POTABLE WATER: (Cont'd)	Springfield Technical Community College	Springfield, MA
	Stanford University	Stanford, CA
	State University of New York at Buffalo	Buffalo, NY
	Stevens Institute of Technology	Hoboken, NJ
	Sumter Technical Community College	Sumter, SC
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	Texas State Technical Institute	Waco, TX
	The Pennsylvania State University	University Park, PA
	The Pennsylvania State University/ Capitol Campus	Middletown, PA
	Tufts University	Boston, MA
	Ulster County Community College	Stone Ridge, NY
	University of California-Berkeley	Berkeley, CA
	University of Florida	Gainesville, FL
	University of Hawaii	Honolulu, HI
	University of Iowa	Iowa City, IA
	University of Kansas	Lawrence, KS
	University of Kentucky	Lexington, KY
	University of Maine at Orono	Orono, ME
	University of Michigan	Ann Arbor, MI
	University of Missouri-Columbia	Columbia, MO
	University of Missouri-Rolla	Rolla, MO
	University of Nebraska	Lincoln, NE
	University of North Carolina	Chapel Hill, NC
	University of Pennsylvania	Philadelphia, PA
	University of Pittsburgh	Pittsburgh, PA
	University of Rhode Island	Kingston, RI
	University of Tennessee	Knoxville, TN
	University of Texas-Austin	Austin, TX
	University of Wisconsin-Madison	Madison, WI
	University of Wyoming	Laramie, WY
	Utah State University	Logan, UT
	Vanderbilt University	Nashville, TN
	Virginia Polytechnic Institute and State University	Blacksburg, VA
	Water and Wastewater Technical School	Neosho, MO
	West Georgia College	Carrollton, GA
	West Virginia University	Morgantown, WV
	Wytheville Community College	Wytheville, VA

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
RADIATION:	Central Florida Community College	Ocala, FL
	Chattanooga State Technical Community College	Chattanooga, TN
	Columbia University	New York, NY
	Cornell University	Ithaca, NY
	Hartford State Technical College	Hartford, CT
	Harvard University School of Public Health	Boston, MA
	Kansas State University	Manhattan, KS
	Massachusetts Institute of Technology	Cambridge, MA
	Memphis State University	Memphis, TN
	Missouri Southern State College	Joplin, MO
	Oak Ridge Associated Universities	Oak Ridge, TN
	Oklahoma State University	Stillwater, OK
	Rensselaer Polytechnic Institute	Troy, NY
	Rutgers State University of New Jersey	New Brunswick, NJ
	St. Louis Community College at Forest Park	St. Louis, MO
	Southern Technical Institute	Marietta, GA
	The Pennsylvania State University	University Park, PA
	University of Florida	Gainesville, FL
	University of Kansas	Lawrence, KS
	University of Lowell	Lowell, MA
	University of Maryland	College Park, MD
	University of Michigan	Ann Arbor, MI
	University of North Carolina	Chapel Hill, NC
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
SOLID WASTE:	Carnegie-Mellon University	Pittsburgh, PA
	Clarkson College	Potsdam, NY
	Cornell University	New York, NY
	Drexel University	Philadelphia, PA
	Hofstra University	Hempstead, NY
	Michigan Technological University	Houghton, MI
	Rensselaer Polytechnic Institute	Troy, NY
	Temple University	Philadelphia, PA
	The Pennsylvania State University	University Park, PA
	University of Iowa	Iowa City, IA
	University of Missouri-Rolla	Rolla, MO
	University of Pittsburgh	Pittsburgh, PA
	Vanderbilt University	Nashville, TN
	West Virginia University	Morgantown, WV
	Wilson County Technical Institute	Wilson, NC
	Yale University	New Haven, CT

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
WASTEWATER:	Atlanta University Center/ Georgia Institute of Technology	Atlanta, GA
	Brigham Young University	Provo, UT
	California State University-Sacramento	Sacramento, CA
	Carnegie-Mellon University	Pittsburgh, PA
	Casper College	Casper, WY
	Central Technical Community College	Hastings, NE
	Charles County Community College	La Plata, MD
	Clarkson College	Potsdam, NY
	Clemson University	Clemson, SC
	Colorado State University	Fort Collins, CO
	Community College of Denver-Red Rocks	Golden, CO
	Cornell University	Ithaca, NY
	Delgado College	New Orleans, LA
	Drexel University	Philadelphia, PA
	East Maine Vocational Technical Institute	Bangor, ME
	Greenville Technical College	Greenville, SC
	Harvard University	Cambridge, MA
	Hudson Valley Community College	Troy, NY
	Illinois Institute of Technology	Chicago, IL
	Iowa State University	Ames, IA
	J. Sargeant Reynolds Community College	Richmond, VA
	Kansas State University	Manhattan, KS
	Kirkwood Community College	Cedar Rapids, IA
	Linn-Benton Community College	Albany, OR
	Manhattan College	New York, NY
	Marquette Technical University	Milwaukee, WI
	Massachusetts Institute of Technology	Cambridge, MA
	Miami-Dade Community College	Miami, FL
	Michigan Technological University	Houghton, MI
	Middlesex County College	Edison, NJ
	Missouri Southern State College	Joplin, MO
	Montana State University	Bozeman, MT
	Muskingum Area Technical College	Zanesville, OH
	New England Regional Wastewater Institute	S. Portland, ME
	New Jersey Institute of Technology	Newark, NJ
	Northeastern University	Boston, MA
	Northern Montana College	Havre, MT
	Ohio State University	Columbus, OH
	Operator Training Center	Murfreesboro, TN
	Oregon Institute of Technology	Klamath Falls, OR
	Oscar Rose Junior College	Midwest City, OK

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
WASTEWATER: (Cont'd)	Purdue University	West Lafayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Rice University	Houston, TX
	Rochester University	Rochester, NY
	Rutgers State University of New Jersey	New Brunswick, NJ
	Southern Illinois University	Edwardsville, IL
	Springfield Technical and Community College	Springfield, MA
	Stanford University	Stanford, CA
	State Technical Institute at Memphis	Memphis, TN
	State University of New York-Buffalo	Buffalo, NY
	Stevens Institute of Technology	Hoboken, NJ
	Sumter Technical Community College	Sumter, SC
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	Texas State Technical Institute	Waco, TX
	The Pennsylvania State University	University Park, PA
	The Pennsylvania State University/ Capitol Campus	Middletown, PA
	Tufts University	Boston, MA
	Ulster County Community College	Stone Ridge, NY
	University of California-Berkeley	Berkeley, CA
	University of Florida	Gainesville, FL
	University of Hawaii	Honolulu HI
	University of Kansas	Lawrence, KS
	University of Kentucky	Lexington, KY
	University of Lowell	Lowell, MA
	University of Maine at Orono	Orono, ME
	University of Missouri-Columbia	Columbia, MO
	University of Missouri-Rolla	Rolla, MO
	University of Nebraska	Lincoln, NE
	University of North Carolina	Chapel Hill, NC
	University of Pittsburgh	Pittsburgh, PA
	University of Rhode Island	Kingston, RI
	University of Tennessee	Knoxville, TN
	University of Texas	Austin, TX
	University of Wisconsin-Madison	Madison, WI
	University of Wyoming	Laramie, WY
	Utah State University	Logan, UT
	Vanderbilt University	Nashville, TN
	Virginia Polytechnic Institute and State University	Blacksburg, VA
	Water and Wastewater Technical School	Neosho, MO
	West Georgia College	Carrollton, GA
	West Virginia University	Morgantown, WV
	Wytheville Community College	Wytheville, VA

APPENDIX V

COLLEGE CATALOGS REVIEWED

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
AL	Alabama A & M University	Huntsville
	Alabama Christian College	Montgomery
	Alabama Lutheran Junior College	Selma
	Alexander City State Junior College	Alexander City
	Athens State College	Athens
	Auburn University	Auburn
	Auburn University at Montgomery	Montgomery
	Birmingham-Southern College	Birmingham
	Brewer State Junior College	Fayette
	Enterprise State Junior College	Enterprise
	Faulkner State Junior College	Bay Minette
	Gadsden State Junior College	Gadsden
	George C. Wallace State Community College	Dothan
	George C. Wallace State Community College	Selma
	Jacksonville State University	Jacksonville
	Jefferson Davis State Junior College	Brewton
	Jefferson State Junior College	Birmingham
	John C. Calhoun State Community College	Decatur
	Judson College	Marion
	Livingston University	Livingston
	Lawson State Community College	Birmingham
	Lurleen B. Wallace State Junior College	Andalusia
	Marion Military Institute	Marion
	Miles College	Birmingham
	Mobile College	Mobile
	Northeast Alabama State Junior College	Rainsville
	Northwest Alabama State Junior College	Phil Campbell
	Oakwood College	Huntsville
	Samford University	Birmingham
	Selma University	Selma
	Snead State Junior College	Boaz
	Southeastern Bible College	Birmingham
	Southern Benedictine College	Saint Bernard
	Southern Union State Junior College	Wadley
	Spring Hill College	Mobile
	Stillman College	Tuscaloosa
	Talladega College	Talladega
	Troy State University	Troy
	Tuskeegee Institute	Tuskeegee Institute
	University of Alabama	University
	University of Alabama in Birmingham	Birmingham
	University of Alabama in Huntsville	Huntsville
	University of Montevallo	Montevallo
	University of North Alabama	Florence
	University of South Alabama	Mobile
	Walker College	Jasper
AK	Sheldon Jackson College	Sitka
	University of Alaska-Fairbanks	Fairbanks
	University of Alaska Juneau Senior College	Juneau
AS	American Samoa Community College	Pago Pago
AZ	American Graduate School of International Management	Glendale
	Arizona State University	Tempe
	Arizona Western College	Yuma

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Central Arizona College	Coolidge
	Cochise College	Douglas
	College of Ganado	Ganado
	DeVry Institute of Technology	Phoenix
	Eastern Arizona College	Thatcher
	Grand Canyon College	Phoenix
	Maricopa County Community College System Office	Phoenix
	Glendale Community College	Glendale
	Maricopa Technical Community College	Phoenix
	Mesa Community College	Mesa
	Phoenix College	Phoenix
	Scottsdale Community College	Scottsdale
	Mohave Community College	Kingman
	Navajo Community College	Tsaile
	Northern Arizona University	Flagstaff
	Northland Pioneer College	Holbrook
	Pima Community College	Tucson
	Southwestern College	Phoenix
	University of Arizona	Tucson
	Yavapai College	Prescott
AR	Arkansas College	Batesville
	Arkansas State University-Main Campus	State University
	Arkansas State University-Beebe Branch	Beebe
	Arkansas Tech University	Russellville
	Central Baptist College	Conway
	College of the Ozarks	Clarksville
	Crowley's Ridge College	Paragould
	Garland County Community College	Hot Springs
	Harding College-Main Campus	Searcy
	Henderson State University	Arkadelphia
	Hendrix College	Conway
	John Brown University	Siloam Springs
	Mississippi County Community College	Blytheville
	Ouachita Baptist University	Arkadelphia
	Philander Smith College	Little Rock
	Phillips County Community College	Helena
	Southern Arkansas University	Magnolia
	Southern Arkansas University Southwest Technical Institute	East Camden
	Southern Baptist College	Walnut Ridge
	Southern State College	Magnolia
	University of Arkansas-Main Campus	Fayetteville
	University of Arkansas-Little Rock	Little Rock
	University of Arkansas Medical Sciences Campus	Little Rock
	University of Arkansas-Monticello	Monticello
	Westlark Community College	Fort Smith
CA	Allan Hancock College	Santa Maria
	Ambassador College	Pasadena
	American Baptist Seminary of the West-Central Office	Berkeley
	American Baptist Seminary of the West-Covina	Covina
	Armstrong College	Berkeley
	Azusa Pacific College	Azusa
	Bakersfield College	Bakersfield
	Barstow College	Barstow
	Bauder College	Sacramento
	Bethany Bible College	Santa Cruz
	Biola College	La Mirada
	Brooks College	Long Beach

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Brooks Institute of Santa Barbara	Santa Barbara
	Butte College	Oroville
	Cabrillo College	Aptos
	California Baptist College	Riverside
	California College of Arts and Crafts	Oakland
	California Institute of the Arts	Valencia
	California Institute of Asian Studies	San Francisco
	California Institute of Technology	Pasadena
	California Lutheran College	Thousand Oaks
	California Maritime Academy	Vallejo
	California State College-San Bernadino	San Bernardino
	California State College-Stanislaus	Turlock
	California Polytechnic State University-San Luis Obispo	San Luis Obispo
	California State University-Fresno	Fresno
	California State University-Fullerton	Fullerton
	California State University-Hayward	Hayward
	California State University-Long Beach	Long Beach
	California State University-Los Angeles	Los Angeles
	California State University-Sacramento	Sacramento
	San Diego State University	San Diego
	San Jose State University	San Jose
	Cerritos College	Norwalk
	Cerro Coso Community College	Ridgecrest
	Chapman College	Orange
	Christian Heritage College	El Cajon
	Church Divinity School of the Pacific	Berkeley
	Citrus College	Azusa
	Claremont Colleges-System Office	Claremont
	Claremont Men's College	Claremont
	Claremont University Center and Graduate School	Claremont
	Harvey Mudd College	Claremont
	Pitzer College	Claremont
	Pomona College	Claremont
	Scripps College	Claremont
	Coast Community College-System Office	Costa Mesa
	Golden West College	Huntington Beach
	Orange Coast College	Costa Mesa
	Cogswell College	San Francisco
	Colegio De La Tierra	Goshen
	College of the Canyons	Valencia
	College of the Desert	Palm Desert
	College of Marin	Kentfield
	College of Notre Dame	Belmont
	College of the Redwoods	Eureka
	College of the Siskiyous	Weed
	Columbia Junior College	Columbia
	Compton Community College	Compton
	Contra Costa Community College-System Office	
	Diablo Valley College	Pleasant Hill
	Cuesta College	San Luis Obispo
	Cypress College	Cypress
	Dominican College of San Rafael	San Rafael
	El Camino College	Torrance
	Foothill-De Anza Community College District-System Office	Los Altos Hills
	De Anza College	Cupertino
	Foothill College	Los Altos Hills
	Fuller Theological Seminary	Pasadena
	Gavilan College	Gilroy
	Glendale Community College	Glendale
	Golden Gate University	San Francisco
	Grossmont College	El Cajon
	Hartnell College	Salinas
	Holy Family College	Mission San Jose

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Holy Names College	Oakland
	Immaculate Heart College	Los Angeles
	Indian Valley Colleges	Novato
	John F. Kennedy University	Orinda
	Lake Tahoe Community College	S. Lake Tahoe
	Lassen College	Susanville
	LaVerne College	La Verne
	L.I.F.E. Bible College	Los Angeles
	Lincoln University	San Francisco
	Lone Mountain College	San Francisco
	Long Beach City College	Long Beach
	Los Angeles Baptist College	Newhall
	Los Angeles Community College-	
	System Office	Los Angeles
	East Los Angeles College	Los Angeles
	Los Angeles City College	Los Angeles
	Los Angeles Harbor College	Wilmington
	Los Angeles Mission College	San Fernando
	Los Angeles Pierce College	Woodland Hills
	Los Angeles Southwest College	Los Angeles
	Los Angeles Valley College	Van Nuys
	West Los Angeles College	Culver City
	Los Rios Community College-	
	System Office	Sacramento
	Cosumnes River College	Sacramento
	Sacramento City College	Sacramento
	Loyla Marymount University	Los Angeles
	Marymount Palos Verdes College	Rancho Palos Verdes
	Mendocino College	Ukiah
	Menlo College	Menlo Park
	Mennonite Brethren Biblical Seminary	Fresno
	Merced College	Merced
	Mills College	Oakland
	Monterey Institute for Foreign Studies	Monterey
	Monterey Peninsula College	Monterey
	Mount San Antonio College	Walnut
	Mount San Jacinto College	San Jacinto
	Napa College	Napa
	National University	San Diego
	New College of California	San Francisco
	Northrop University	Inglewood
	Occidental College	Los Angeles
	Ohlone College	Fremont
	Otis Art Institute of Los Angeles County	Los Angeles
	Pacific Christian College	Fullerton
	Pacific College	Fresno
	Pacific Oaks College	Pasadena
	Pacific School of Religion	Berkeley
	Pacific Union College	Angwin
	Palomar College	San Marcos
	Palo Verde College	Blythe
	Pasadena City College	Pasadena
	Patten Bible College	Oakland
	Pepperdine University	Malibu
	Peralta Community Colleges-System Office	Oakland
	College of Alameda	Alameda
	Point Loma College	San Diego
	Porterville College	Porterville
	Rand Graduate Institute of Policy Studies	Santa Monica
	Riverside City College	Riverside
	Rosemead Graduate School of Psychology	Rosemead
	Saddleback Community College	Mission Viejo
	Saint Mary's College of California	Moraga

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Saint Patrick's College	Mountain View
	San Diego Community College- Central Office	San Diego
	San Diego Community College- City College	San Diego
	San Diego Community College- Evening College	
	San Francisco Art Institute	San Francisco
	San Francisco Conservatory of Music	San Francisco
	San Francisco Theological Seminary	San Anselmo
	San Joaquin Delta College	Stockton
	San Jose Community College District-	
	Evergreen Valley College	San Jose
	San Jose City College	San Jose
	San Mateo County Community College	
	District-System Office	San Mateo
	Canada College	Redwood City
	College of San Mateo	San Mateo
	Skyline College	San Bruno
	Santa Ana College	Santa Ana
	Santa Barbara City College	Santa Barbara
	Santa Monica College	Santa Monica
	Santa Rosa Junior College	Santa Rosa
	Shasta College	Redding
	Sierra College	Rocklin
	Simpson College	San Francisco
	Solano Community College	Suisun City
	Southern California College	Costa Mesa
	Southern California College of Optometry	Fullerton
	Southwestern University School of Law	Los Angeles
	Stanford University	Stanford
	State Center Community College District	
	Fresno City College	Fresno
	Reedley College	Reedley
	Taft College	Taft
	United States International University	San Diego
	University of California-Berkeley	Berkeley
	University of California-Davis	Davis
	University of California Hastings College of Law	San Francisco
	University of California-Irvine	Irvine
	University of California-Los Angeles	Los Angeles
	University of California-Riverside	Riverside
	University of California-San Francisco	San Francisco
	University of California-Santa Barbara	Santa Barbara
	University of the Pacific	Stockton
	University of Redlands	Redlands
	University of San Diego	San Diego
	University of San Francisco	San Francisco
	University of Santa Clara	Santa Clara
	University of Southern California	Los Angeles
	University of West Los Angeles	Culver City
	Ventura County Community College District	
	Moorpark College	Moorpark
	Oxnard College	Oxnard
	Ventura College	Ventura
	West Coast Bible College	Fresno
	West Coast University Central Office	Los Angeles
	West Coast University Orange County Center	Orange
	Western State University College of Law- Orange County	Fullerton
	Western State University College of Law- San Diego	San Diego
	West Hills College	Coalinga
	Westmont College	Santa Barbara
	West Valley College	Saratoga

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Whittier College	Whittier
	Woodbury University	Los Angeles
	The Wright Institute	Berkeley
	Yuba College	Marysville
CO	Adams State College	Alamosa
	Aims Community College	Greeley
	Arapahoe Community College	Littleton
	Colorado College	Colorado Springs
	Colorado Mountain College-East Campus	Leadville
	Colorado Mountain College-West Campus	Glenwood Springs
	Colorado School of Mines	Golden
	Colorado State University	Fort Collins
	Colorado Technical College	Manitou Springs
	Colorado Women's College	Denver
	Community College of Denver-Auraria Campus	Denver
	Community College of Denver-North Campus	Denver
	Community College of Denver-Red Rocks Campus	Golden
	Conservative Baptist Theological Seminary	Denver
	El Paso Community College	Colorado Springs
	Fort Lewis College	Durango
	Iliff School of Theology	Denver
	Lamar Community College	Lamar
	Loretto Heights College	Denver
	Mesa College	Grand Junction
	Metropolitan State College	Denver
	Morgan Community College	Fort Morgan
	Northeastern Junior College	Sterling
	Ortero Junior College	La Junta
	Regis College	Denver
	Rockmont College	Denver
	Saint Thomas Seminary	Denver
	Trinidad State Junior College	Trinidad
	University of Colorado-Boulder	Boulder
	University of Colorado-Colorado Springs	Colorado Springs
	University of Colorado-Denver	Denver
	University of Denver	Denver
	University of Denver College of Law	Denver
	University of Northern Colorado	Greeley
	University of Southern Colorado	Pueblo
	Western Bible College	Morrison
	Western State College of Colorado	Gunnison
CT	Albertus Magnus College	New Haven
	Annhurst College	Woodstock
	Bridgeport Engineering Institute	Bridgeport
	Connecticut College	New London
	Eastern Connecticut State College	Willimnatic
	Greater Hartford Community College	Hartford
	Hartford State Technical College	Hartford
	Housatonic Regional Community College	Bridgeport
	Mattuck Community College	Waterbury
	Middlesex Community College	Middletown
	Mitchell College	New London
	Mohegan Community College	Norwich
	Northwestern Connecticut Community College	Winsted
	Norwalk Community College	Norwald
	Post Junior College	Waterbury
	Quinebaug Valley Community College	Danielson
	Saint Joseph College	West Hartford

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Thames Valley State Technical College	Norwich
	Trinity College	Hartford
	Tunxis Community College	Farmington
	University of Bridgeport	Bridgeport
	University of Hartford	West Hartford
	University of New Haven	West Haven
	Yale University	New Haven
DE	Delaware State College	Dover
	Delaware Technical and Community College	Dover
	Goldey Beacom College	Wilmington
	University of Delaware	Newark
	Wesley College	Dover
DC	American University	Washington
	Catholic University of America	Washington
	District of Columbia Teachers College	Washington
	Gallaudet College	Washington
	George Washington University	Washington
	Howard University	Washington
	Mount Vernon College	Washington
	Trinity College	Washington
FL	Barry College	Miami
	Brevard Community College	Cocoa
	Broward Community College	Fort Lauderdale
	Central Florida Community College	Ocala
	Chipola Junior College	Marianna
	College of Boca Raton	Boca Raton
	Daytona Beach Community College	Daytona Beach
	Eckerd College	St. Petersburg
	Edison Community College	Fort Meyers
	Embry-Riddle Aeronautical University	Daytona Beach
	Flagler College	St. Augustine
	Florida A & M University	Tallahassee
	Florida Atlantic University	Boca Raton
	Florida College	Temple Terrace
	Florida International University	Miami
	Florida Junior College	Jacksonville
	Florida Keys Community College	Key West
	Florida Southern College	Lakeland
	Florida Technological University	Orlando
	Fort Lauderdale College	Fort Lauderdale
	Gulf Coast Community College	Panama City
	Heed University	Hollywood
	Hillsborough Community College	Tampa
	Indian River Community College	Fort Pierce
	Jacksonville University	Jacksonville
	Jones College	Jacksonville
	Lake City Community College	Lake City
	Lake-Sumter Community College	Leesburg
	Manatee Junior College	Bradenton
	Miami Christian College	Miami
	Miami-Dade Community College	Miami
	North Florida Junior College	Madison
	Nova University	Fort Lauderdale
	Okaloosa-Walton Junior College	Niceville
	Palm Beach Atlantic College	West Palm Beach
	Palm Beach Junior College	Lake Worth
	Pensacola Junior College	Pensacola
	Polk Community College	Winter Haven

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Rollins College	Winter Park
	Saint Johns River Junior College	Palatka
	Saint Leo College	Saint Leo
	Santa Fe Community College	Gainesville
	Seminole Community College	Sanford
	South-Eastern Bible College	Lakeland
	South Florida Junior College	Avon Park
	University of Florida	Gainesville
	University of Miami	Coral Gables
	University of North Florida	Jacksonville
	Warner Southern College	Lake Wales
	Webber College	Babson Park
GA	Abraham Baldwin Agricultural College	Tifton
	Agnes Scott College	Decatur
	Albany Area Vocational Technical School	Albany
	Albany Junior College	Albany
	Albany State College	Albany
	Andrew College	Cuthbert
	Armstrong State College	Savannah
	Atlanta Christian College	East Point
	Atlanta Junior College	Atlanta
	Atlanta University	Atlanta
	Augusta College	Augusta
	Bainbridge Junior College	Bainbridge
	Berry College	Mount Berry
	Brenau College	Gainesville
	Brewton-Parker College	Mount Vernon
	Carroll County Area Vocational-Technical School	Carrollton
	Carver Bible Institute and College	Atlanta
	Clark College	Atlanta
	Clayton Junior College	Morrow
	Columbus College	Columbus
	Dalton Junior College	Dalton
	DeKalb Community College	Clarkston
	Emanuel County Junior College	Swainsboro
	Emory University	Atlanta
	Fort Valley State College	Fort Valley
	Gainesville Junior College	Gainesville
	Georgia College	Milledgeville
	Georgia Institute of Technology	Atlanta
	Georgia Military College	Milledgeville
	Georgia Southern College	Statesboro
	Georgia Southwestern College	Americus
	Georgia State University	Atlanta
	Gordon Junior College	Barnesville
	Kennesaw Junior College	Marietta
	LaGrange College	LaGrange
	Macon Junior College	Macon
	Marietta-Cobb Area Vocational Technical School	Marietta
	Mercer University	Macon
	Mercer University in Atlanta	Atlanta
	Middle Georgia College	Cochran
	Morehouse College	Atlanta
	Moultrie Area Vocational-Technical School	Moultrie
	North Georgia College	Dahlonega
	North Georgia Technical and Vocational School	Clarkesville
	Oglethorpe College	Atlanta
	Pickens Area Vocational-Technical School	Jasper
	Piedmont College	Demorest
	Reinhardt College	Waleska

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Savannah Area Vocational Technical School	Savannah
	Savannah State College	Savannah
	Shorter College	Rome
	South Georgia College	Douglas
	South Georgia Technical and Vocational School	Americus
	Southern Technical Institute	Marietta
	Swainsboro Area Vocational-Technical School	Swainsboro
	Thomas Area Vocational-Technical School	Thomasville
	Tift College	Forsyth
	Toccoa Falls College	Toccoa Falls
	Troup County Area Vocational Technical School	LaGrange
	Truett McCornell College	Cleveland
	University of Georgia	Athens
	Upson County Area Vocational-Technical School	Thomaston
	Valdosta State College	Valdosta
	Valdosta Technical School	Valdosta
	Walker County Area Technical School	Rock Spring
	Waycross-Ware Area Technical School	Waycross
	Wesleyan College	Macon
	West Georgia College	Carrollton
	Young Harris College	Young Harris
HI	Brigham Young University-Hawaii Campus	Laie Oahu
	Chaminade College of Honolulu	Honolulu
	Hawaii Pacific College	Honolulu
	University of Hawaii-Honolulu Community College	Honolulu
	University of Hawaii-Kapiolani Community College	Honolulu
	University of Hawaii-Kauai Community College	Lihue
	University of Hawaii-Leeward Community College	Pearl City
	University of Hawaii-Manoa	Honolulu
	University of Hawaii-Maui Community College	Kahului
	University of Hawaii-Windward Community College	Kaneohe
ID	Boise State University	Boise
	College of Southern Idaho	Twin Falls
	Idaho State University	Pocatello
	North Idaho College	Coeur D'Alene
	Northwest Nazarene College	Nampa
	Ricks College	Rexburg
	University of Idaho	Moscow
IL	Augustana College	Rock Island
	Aurora College	Aurora
	Barat College	Lake Forest
	Belleville Area College	Belleville
	Blackburn College	Carlinville
	Black Hawk College	Moline
	Bradley University	Peoria
	Carl Sandburg College	Galesburg
	Central YMCA Community College	Chicago
	Chicago College of Osteopathic Medicine	Chicago
	Chicago State University	Chicago
	College of DuPage	Glen Ellyn

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	College of Lake County	Grayslake
	College of St. Francis	Joliet
	College of the University of Chicago	Chicago
	Danville Junior College	Danville
	DeLourdes College	Des Plaines
	DePaul University	Chicago
	DeVry Institute of Technology	Chicago
	Eastern Illinois University	Charleston
	Elgin Community College	Elgin
	Elmhurst College	Elmhurst
	Eureka College	Eureka
	George Williams College	Downers Grove
	Governors State University	Park Forest South
	Greenville College	Greenville
	Highland Community College	Freeport
	Illinois Benedictine College	Lisle
	Illinois Central College	East Peoria
	Illinois College	Jacksonville
	Illinois College of Optometry	Chicago
	Illinois College of Podiatric Medicine	Chicago
	Illinois Institute of Technology	Chicago
	Illinois State University	Normal
	Illinois Valley Community College	Oglesby
	Illinois Wesleyan University	Bloomington
	Joliet Junior College	Joliet
	Judson College	Elgin
	Kankakee Community College	Kankakee
	Kendall College	Evanston
	Kishwaukee College	Malta
	Knox College	Galesburg
	Lake Forest College	Evanston
	Lakeland College	Mattoon
	Lewis and Clark Community College	Godfrey
	Lincoln Trail College	Robinson
	Logan (John A.) College	Carterville
	Loyola University of Chicago	Chicago
	MacMurray College	Jacksonville
	McHenry County College	Crystal Lake
	McKendree College	Lebanon
	Meadville Theological School	Lombard
	Millikin University	Decatur
	Moraine Valley Community College	Palos Hills
	National College of Chiropractic	Lombard
	North Central College	Naperville
	Northeastern Illinois University	Chicago
	Northern Baptist Theological Seminary	Lombard
	Northern Illinois University	DeKalb
	Northwestern University	Evanston
	Oakton Community College	Morton Grove
	Olivet Nazarene College	Kankakee
	Olney Central College	Mt. Carmel
	Prairie State Community College	Chicago Heights
	Rockford College	Rockford
	Rock Valley College	Rockford
	Roosevelt University	Chicago
	Rush University, College of Nursing and Allied Health Sciences	Chicago
	Rush University, Rush Medical College	Chicago
	Sangamon State University	Springfield
	Sauk Valley College	Dixon
	Southern Illinois University	Carbondale
	Southern Illinois University	Edwardsville
	Spertus College of Judaica	Chicago
	Spoon River College	Canton
	Springfield College in Illinois	Springfield

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	State Community College of East Saint Louis, Illinois	East St. Louis
	Thornton Community College	South Holland
	Triton College	River Grove
	University of Health Sciences, The Chicago Medical School	Chicago
	University of Illinois at Chicago Circle	Chicago
	University of Illinois at the Medical Center, School of Public Health	Chicago
	University of Illinois at Urbana-Champaign	Urbana-Champaign
	Wabash Valley College	Mt. Carmel
	Waubonsee Community College	Sugar Grove
	Western Illinois University	Macomb
	Wheaton College	Wheaton
	William Rainey Harper College	Palatine
IN	Anderson College	Anderson
	Associated Mennonite Biblical Seminary	Elkhart
	Ball State University	Muncie
	Bethel College	Mishawaka
	Butler University	Indianapolis
	DePauw University	Greencastle
	Earlham College	Richmond
	Franklin College	Franklin
	Goshen College	Goshen
	Grace College	Winona Lake
	Hanover College	Hanover
	Holy Cross Junior College	Notre Dame
	Huntington College	Huntington
	Indiana Central College	Indianapolis
	Indiana Institute of Technology	Fort Wayne
	Indiana State University	Evansville
	Indiana University	Bloomington
	Indiana University-East	Richmond
	Indiana University-Kokomo	Kokomo
	Indiana University-Northwest	Gary
	Indiana University-South Bend	South Bend
	Indiana University-Southeast	New Albany
	Indiana University-Purdue University at Fort Wayne	Fort Wayne
	Indiana Vocational Technical College	Indianapolis
	International Junior College	Fort Wayne
	Manchester College	North Manchester
	Marian College	Indianapolis
	Marion College	Marion
	Oakland College	Oakland City
	Purdue State University	Muncie
	Purdue University	West Lafayette
	Purdue University-Calumet	Calumet
	Purdue University-North Central	Westville
	Rose-Hulman Institute of Technology	Terre Haute
	Saint Joseph's College	Rensselaer
	Saint Mary's College	Notre Dame
	Saint Mary of the Woods College	Saint Mary of the Woods
	Saint Meinard College	St. Meinard
	Taylor University	Upland
	Tri-State University	Angola
	University of Evansville	Evansville
	University of Notre Dame	South Bend
	Valparaiso University	Valparaiso
	Vincennes University	Vincennes
	Wabash College	Crawfordsville

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
IA	Area One Vocational-Technical School	Calmar and Dubuque
	Briar Cliff College	Sioux City
	Central College	Pella
	Clarke College	Dubuque
	Coe College	Cedar Rapids
	Cornell College	Mt. Vernon
	Des Moines Area Community College	Ankeny
	Drake University	Des Moines
	Ellsworth Community College	Iowa Falls
	Grinnell College	Grinnell
	Hawkeye Institute of Technology	Waterloo
	Iowa Central Community College	Fort Dodge
	Iowa Lakes Community College	Estherville
	Iowa State University	Ames
	Iowa Wesleyan College	Mount Pleasant
	Iowa Western Community College	Council Bluffs
	Kirkwood Community College	Cedar Rapids
	Loras College	Dubuque
	Luther College	Decorah
	Marshalltown Community College	Marshalltown
	Marycrest College	Davenport
	Morningside College	Sioux City
	Mount Mercy College	Cedar Rapids
	North Iowa Area Community College	Mason City
	Open Bible College	Des Moines
	Palmer College of Chiropractic	Davenport
	Simpson College	Indianola
	Southeastern Community College	Burlington
	Southwestern Community College	Creston
	University of Dubuque	Dubuque
	University of Dubuque Theological Seminary	Dubuque
	University of Iowa	Iowa City
	University of Northern Iowa	Cedar Falls
	Upper Iowa University	Fayette
	Wartburg College	Waverly
	Wartburg Seminary	Dubuque
	Westmar College	LeMars
	Western Iowa Technical Community College	Sioux City
KS	Allen County Community Junior College	Iola
	Baker University	Baldwin
	Barton County Community College	Great Bend
	Benedictine College	Atchison
	Bethel College	North Newton
	Central College	McPherson
	Cloud County Community College	Concordia
	Coffeyville Community Junior College	Coffeyville
	Colby Community College	Colby
	Cowley County Community College	Arkansas City
	Dodge City Community College	Dodge City
	Donnelly College	Kansas City
	Emporia Kansas State College	Emporia
	Fort Hays Kansas State College	Hays
	Fort Scott Community College	Fort Scott
	Friends Bible College	Haviland
	Garden City Community College	Garden City
	Haskell Indian Junior College	Lawrence
	Hesston College	Hesston
	Highland Community Junior College	Highland
	Hutchinson Community Junior College	Hutchinson
	Independence Community Junior College	Independence
	Johnson County Community College	Overland Park
	Kansas City Community College	Kansas City

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Kansas Newman College	Wichita
	Kansas State College of Pittsburg	Pittsburg
	Kansas State University	Manhattan
	Kansas Technical Institute	Salina
	Kansas Wesleyan	Salina
	Labette Community Junior College	Parsons
	Manhattan Christian College	Manhattan
	Marymount College of Kansas	Salina
	McPherson College	McPherson
	Mid-America Nazarene College	Olathe
	Neosho County Community Junior College	Chanute
	Ottawa University	Ottawa
	Pratt Community College	Pratt
	Saint John's College	Winfield
	Saint Mary College	Leavenworth
	Saint Mary of the Plains College	Dodge City
	Seward County Community College	Liberal
	Southwestern College in Kansas	Winfield
	Sterling College	Sterling
	Tabor College	Hillsboro
	The University of Kansas	Lawrence
	Washburn University of Topeka	Topeka
	Wichita State University	Wichita
KY	Alice Lloyd College	Pippa Passes
	Asbury College	Wilmore
	Bellarmine College	Louisville
	Berea College	Berea
	Brescia College	Owensboro
	Campbellsville College	Campbellsville
	Centre College of Kentucky	Danville
	Cumberland College	Williamsburg
	Eastern Kentucky University	Richmond
	Georgetown College	Georgetown
	Jefferson Vocational Regional Office	Jeffersontown
	Kentucky Christian College	Grayson
	Kentucky State University	Frankfort
	Kentucky Wesleyan College	Owensboro
	Lees Junior College	Jackson
	Lindsey Wilson College	Columbia
	Midway College	Midway
	Morehead State University	Morehead
	Murray State University	Murray
	Pikeville College	Pikeville
	Saint Catharine College	Saint Catharine
	Southeastern Christian College	Winchester
	Sue Bennett College	London
	Thomas More College	Fort Mitchell
	Transylvania University	Lexington
	University of Kentucky	Lexington
	University of Kentucky Community College System	Lexington
	University of Louisville	Louisville
	Western Kentucky University	Bowling Green
LA	Bossier Parish Community College	Bossier City
	Centenary College of Louisiana	Shreveport
	Delgado College	New Orleans
	Dillard University	New Orleans
	Grambling State University	Grambling
	Louisiana State University-Central Office	Baton Rouge

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Louisiana State University and Agricultural and Mechanical College at Baton Rouge	Baton Rouge
	Louisiana State University-Alexandria	Alexandria
	Louisiana State University-Eunice	Eunice
	Louisiana State University-Shreveport	Shreveport
	University of New Orleans	New Orleans
	Louisiana Tech University	Ruston
	McNeese State University	Lake Charles
	New Orleans Baptist Theological Seminary	New Orleans
	Northeast Louisiana University	Monroe
	Northwestern State University of Louisiana	Natchitoches
	Notre Dame Seminary School of Theology	New Orleans
	Our Lady of Holy Cross College	New Orleans
	Saint Bernard Parish Community College	Chalmette
	Saint Joseph Seminary College	Saint Benedict
	Saint Mary's Dominican College	New Orleans
	Southern University in New Orleans	New Orleans
	Tulane University of Louisiana	New Orleans
	Xavier University of Louisiana	New Orleans
ME	Bowdoin College	Brunswick
	Colby College	Waterville
	College of the Atlantic	Bar Harbor
	Eastern Maine Vocational and Technical Institute	Bangor
	Maine Maritime Academy	Castine
	Masson College	Springvale
	South Maine Vocational and Technical Institute	South Portland
	Unity College	Unity
	University of Maine at Orono	Orono
MD	Bowie State College	Bowie
	Catonsville Community College	Catonsville
	Charles County Community College	La Plata
	Chesapeake College	Wye Mills
	Columbia Union College	Takoma Park
	Community College of Baltimore	Baltimore
	Dundalk Community College	Baltimore
	Essex Community College	Baltimore County
	Garrett Community College	McHenry
	Goucher College	Towson
	Hagerstown Junior College	Hagerstown
	Harford Community College	Bel Air
	Hood College	Frederick
	Howard Community College	Columbia
	Johns Hopkins University	Baltimore
	Loyola College	Baltimore
	Montgomery College	Rockville
	Saint John's College	Annapolis
	Saint Mary's College of Maryland	Saint Mary's City
	Towson State College	Baltimore
	University of Baltimore	Baltimore
	University of Maryland	College Park
	Villa Julie College	Stevenson
	Washington College	Chestertown

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
MA	Amherst College	Amherst
	Anna Maria College	Paxton
	Assumption College	Worcester
	Bay Path Junior College	Longmeadow
	Bentley College	Waltham
	Boston College	Chestnut Hill
	Boston University	Boston
	Gordon College	Wenham
	Hampshire College	Amherst
	Harvard University	Cambridge
	Lasell Junior College	Auburndale
	Lesley College	Cambridge
	Massachusetts Institute of Technology	Cambridge
	Merrimack College	North Andover
	Mount Holyoke College	South Hadley
	Nichols College	Dudley
	Northeastern University	Boston
	Regis College	Weston
	Simon's Rock	Great Barrington
	Smith College	Northampton
	Southeastern Massachusetts University	North Darmouth
	Springfield College	Springfield
	Springfield Technical Community College	Springfield
	Stonehill College	North Easton
	Suffolk University	Boston
	Tufts University	Medford
	University of Massachusetts	Boston
	Wentworth Institute	Boston
	Wheelock College	Boston
	Williams College	Williamstown
	Worcester Junior College	Worcester
	Worcester Polytechnic Institute	Worcester
MI	Alma College	Alma
	Alpena Community College	Alpena
	Andrews University	Berrien Springs
	Aquinas College	Grand Rapids
	Bay de Noc Community College	Escanaba
	Calvin College	Grand Rapids
	Calvin Theological Seminary	Grand Rapids
	Central Michigan University	Mount Pleasant
	Concordia Lutheran Junior College	Ann Arbor
	Delta College	University Center
	Detroit Institute of Technology	Detroit
	Eastern Michigan University	Ypsilanti
	Ferris State College	Big Rapids
	General Motors Institute	Flint
	Grace Bible College	Wyoming
	Grand Rapids Baptist College	Grand Rapids
	Grand Rapids Junior College	Grand Rapids
	Grand Valley State College	Allendale
	Highland Park Community College	Highland Park
	Hillsdale College	Hillsdale
	Hope College	Holland

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Jackson Community College	Jackson
	Kalamazoo College	Kalamazoo
	Kalamazoo Valley Community College	Kalamazoo
	Kirtland Community College	Roscommon
	Lake Michigan College	Benton Harbor
	Lake Superior State College	Saulte Ste. Marie
	Lansing Community College	Lansing
	Macomb County Community College	Warren
	Madonna College	Livonia
	Marygrove College	Detroit
	Mercy College of Detroit	Detroit
	Merrill-Palmer Institute	Detroit
	Michigan Department of Education-Environmental Guidelines	Lansing
	Michigan State University	East Lansing
	Michigan Technological University	Houghton
	Mid Michigan Community College	Harrison
	Monroe County Community College	Monroe
	Montcalm Community College	Sidney
	Mott Community College	Flint
	Muskegon Business College	Muskegon
	Muskegon Community College	Muskegon
	Northern Michigan University	Marquette
	Northwestern Michigan College	Traverse City
	Oakland Community College	Bloomfield Hills
	Oakland University	Rochester
	Olivet College	Olivet
	Saginaw Valley State College	University Center
	Saint Mary's College	Orchard Lake
	Schoolcraft College	Livonia
	Shaw College at Detroit	Detroit
	Southwestern Michigan College	Dowagiac
	Spring Arbor College	Spring Arbor
	Suomi College	Hancock
	University of Detroit	Detroit
	University of Michigan	Ann Arbor
	Walsh College	Troy
	Washtenaw Community College	Ann Arbor
	Wayne County Community College	Detroit
	Wayne State University	Detroit
	Western Michigan University	Kalamazoo
	West Shore Community College	Scottville
	Western Theological Seminary	Holland
MN	Anoka-Ramsey Community College	Coon Rapids
	Augsburg College	Minneapolis
	Austin Community College	Austin
	Bemidji State University	Bemidji
	Bethany Lutheran College	Mankato
	Brainerd Community College	Brainerd
	Carleton College	Northfield
	College of Saint Benedict	St. Joseph
	College of St. Catherine	St. Paul
	College of St. Scholastica	Duluth
	College of St. Thomas	St. Paul
	Concordia College	Moorhead
	Crosier Seminary Junior College	Onamia
	Dr. Martin Luther College	New Ulm
	Fergus Falls Community College	Fergus Falls
	Hibbing Community College	Hibbing
	Itasca Community College	Grand Rapids
	Lakewood Community College	White Bear Lake
	Luther Theological Seminary	St. Paul
	Macalester College	St. Paul
	Mankato State University	Mankato

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Mesabi Community College	Virginia
	Metropolitan Community College	Minneapolis
	Metropolitan State University	St. Paul
	Minneapolis College of Art and Design	Minneapolis
	Minnesota Bible College	Rochester
	Moorhead State College	Moorhead
	Normandale Community College	Bloomington
	North Hennepin Community College	Minneapolis
	Northland Community College	Thief River Falls
	Northwestern College	Roseville
	Rainy River Community College	International Falls
	Rochester Community College	Rochester
	Saint John's University	Collegeville
	Saint Mary's College	Winona
	Southwest Minnesota State College	Marshall
	St. Cloud Area Vocational Technical Institute	St. Cloud
	St. Cloud State University	St. Cloud
	St. Mary's Junior College	Minneapolis
	St. Paul Bible College	Bible College
	United Theological Seminary of the Twin Cities	New Brighton
	University of Minnesota	Minneapolis
	Vermilion Community College	Ely
	William Mitchell College of Law	St. Paul
	Winona State University	Winona
	Worthington Community College	Worthington
MS	Alcorn State University	Lorman
	Belhaven College	Jackson
	Clarke College	Newton
	Coahoma Junior College	Clarksdale
	Copiah-Lincoln Junior College	Wesson
	Delta State University	Cleveland
	East Central Junior College	Decatur
	East Mississippi Junior College	Scooba
	Hinds Junior College	Raymond
	Holmes Junior College	Goodman
	Itawamba Junior College	Fulton
	Jackson State University	Jackson
	John C. Stennis Vocational Complex	Dekalb
	Jones County Junior College	Ellisville
	Mary Holmes College	West Point
	Meridian Junior College	Meridian
	Millsaps College	Jackson
	Mississippi College	Clinton
	Mississippi Delta Junior College	Moorhead
	Mississippi Gulf Coast Junior College	Perkinston
	Mississippi Industrial College	Holly Springs
	Mississippi State University	Mississippi State
	Mississippi University for Women	Columbus
	Northeast Mississippi Junior College	Booneville
	Northwest Mississippi Junior College	Senatobia
	Pearl River Junior College	Poplarville
	Rust College	Holly Springs
	Southwest Mississippi Junior College	Summit
	Tougaloo College	Tougaloo
	University of Mississippi	University
	University of Mississippi Medical Center	Jackson
	University of Southern Mississippi	Hattiesburg
	Utica Junior College	Utica
	Wesley College	Florence
	William Carey College	Hattiesburg
	Wood Junior College	Mathiston

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
MO	Assemblies of God Graduate School	Springfield
	Avila College	Kansas City
	Calvary Bible College	Kansas City
	Central Bible College	Springfield
	Central Methodist College	Fayette
	Central Missouri State University	Warrensburg
	Columbia College	Columbia
	Concordia Seminary	St. Louis
	Cottey College	Nevada
	Crowder College	Neosho
	Culver-Stockton College	Canton
	Fontbonne College	St. Louis
	Hannibal Lagrange College	Hannibal
	Harris Teachers College	St. Louis
	Jefferson College	Hillsboro
	Kansas City Art Institute	Kansas City
	Kansas City College of Osteopathic Medicine	Kansas City
	Logan College of Chiropractic	Chesterfield
	Longview Community College	Kansas City
	Maple Woods Community College	Kansas City
	Maryville College	St. Louis
	Meramec Community College	St. Louis
	Missouri Baptist College	St. Louis
	Missouri Southern State College	Joplin
	Moberly Area Junior College	Moberly
	Northeast Missouri State University	Kirksville
	Northwest Missouri State University	Maryville
	Rockhurst College	Kansas City
	Saint Louis College of Pharmacy	St. Louis
	Saint Louis Community College at Forest Park	St. Louis
	Saint Louis University	St. Louis
	Saint Paul's College	Concordia
	School of the Ozarks	Point Lookout
	Southwest Missouri State University	Springfield
	State Fair Community College	Sedalia
	Stephen's College	Columbia
	Tarkio College	Tarkio
	The Principia	St. Louis
	Three Rivers Community College	Poplar Bluff
	University of Missouri-Columbia	Columbia
	University of Missouri-Kansas City	Kansas City
	University of Missouri-Rolla	Rolla
	University of Missouri-St. Louis	St. Louis
	Washington University	St. Louis
	Water and Wastewater Technical School	Neosho
	Webster College	Webster
	Westminster College	Fulton
	William Jewell College	Kansas City
MT	Carroll College	Helena
	College of Great Falls	Great Falls
	Dawson College	Glendive
	Eastern Montana College	Billings
	Flathead Valley Community College	Kalispell
	Miles Community College	Miles City
	Montana College of Mineral Science and Technology	Butte
	Montana State University	Bozeman
	Northern Montana College	Havre
	Rocky Mountain College	Billings
	University of Montana	Missoula
	Western Montana College	Dillon

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
NE	Central Technical Community College	Hastings
	Chadron State College	Chadron
	College of Saint Mary	Omaha
	Concordia College	Seward
	Creighton University	Omaha
	Dana College	Blair
	Doane College	Crete
	Grace College of the Bible	Omaha
	Hastings College	Hastings
	Kearney State College	Kearney
	McCook Community College	McCook
	Midland Lutheran College	Fremont
	Mid-Plains Community College	North Platte
	Northeast Technical Community College	Norfolk
	Platte Technical Community College	Columbus
	Southeast Community College	Lincoln
	Union College	Lincoln
	University of Mid-America	Lincoln
	University of Nebraska	Lincoln
	Wayne State College	Wayne
NV	University of Nevada-Las Vegas	Las Vegas
	University of Nevada-Reno	Reno
	Clark County Community College	Las Vegas
	Northern Nevada Community College	Elko
	Sierra Nevada College	Incline Village
	Western Nevada Community College	Carson City
NH	Colby-Sawyer College	New London
	Dartmouth College	Hanover
	Franklin Pierce College	Rindge
	New England College	Henniker
	NH Technical Institute	Concord
	NH Voc-Tech College of Berlin	Berlin
	NH Voc-Tech College of Claremont	Claremont
	NH Voc-Tech College of Laconia	Laconia
	NH Voc-Tech College of Manchester	Manchester
	NH Voc-Tech College of Nashua	Nashua
	NH Voc-Tech College of Portsmouth	Portsmouth
	Saint Anselm's College	Manchester
	University of New Hampshire	Durham
	White Pines College	Chester
NJ	Atlantic Community College	Mays Landing
	Bergen Community College	Paramus
	Brookdale Community College	Lincroft
	Burlington County College	Penberton
	Camden County College	Caldwell
	Centenary College for Women	Hackettstown
	County College of Morris	Dover
	Cumberland County College	Vineland
	Drew University	Madison
	Fairleigh Dickinson University	Rutherford
	Gloucester County College	Sewell
	Kean College of New Jersey	Union
	Mercer County Community College	Trenton
	Middlesex County College	Edison
	Montclair State College	Upper Montclair
	New Jersey Institute of Technology	Newark
	Ocean County College	Toms River
	Passaic County Community College	Paterson
	Princeton University	Princeton

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Rider College	Trenton
	Rutgers the State University	New Brunswick
	Stevens Institute of Technology	Hoboken
	Trenton State College	Trenton
	Union College	Cranford
	Union County Technical Institute	Scotch Plains
	William Paterson College	Wayne
NM	College of the Southwest	Hobbs
	Eastern New Mexico University-Main Campus	Portales
	Eastern New Mexico University-Roswell	Roswell
	New Mexico Highlands University	Las Vegas
	New Mexico Institute of Mining and Technology	Socorro
	New Mexico Junior College	Hobbs
	New Mexico Military Institute	Roswell
	New Mexico State University-Las Cruces	Las Cruces
	New Mexico State University-San Juan	San Juan
	University of Albuquerque	Albuquerque
	University of New Mexico-Main Campus	Albuquerque
NY	Adelphi University	Garden City
	Albany College Pharmacy	Albany
	Albany Law School	Albany
	Alfred University	Alfred
	Bard College	Annandale-on-Hudson
	Bronx Community College	Bronx
	Brooklyn Law School	Brooklyn
	Canisius	Buffalo
	City University of New York	New York
	Clarkson College of Technology	Potsdam
	Colgate University	Hamilton
	College of Mt. Saint Vincent	Riverdale
	College of Saint Rose	Albany
	Columbia University	New York
	Concordia College	Bronxfille
	Cornell University	Ithaca
	Dowling College	Oakdale Long Island
	D'Youville College	Buffalo
	Erie Community College	Buffalo
	Hamilton College	Clinton
	Hartwick College	Oneonta
	Hilbert College	Hamburg
	Hobart-William Smith Colleges	Geneva
	Hofstra University	Hempstead
	Houghton College	Houghton
	Hudson Valley Community College	Troy
	Hunter College	New York
	Ithaca College	Ithaca
	King's College	Briarcliff Manor
	Long Island University	Greenvale
	Manhattan College	Bronx
	Medaille College	Buffalo
	Mercy College	Dobbs Ferry
	Molloy College	Rockville Centre
	New School for Social Research	New York
	New York Institute of Technology	Old Westbury
	New York Law School	New York
	Niagara University	Niagara University

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Paul Smith's College of Arts & Science	Paul Smiths
	Polytechnic Institute of New York	Brooklyn
	Rensselaer Polytechnic Institute	Troy
	Roberts Wesleyan College	Rochester
	Rochester Institute of Technology	Rochester
	Rockefeller University	New York
	Saint Banaventure University	Saint Bonaventure
	Saint John Fisher College	Rochester
	Saint John's University	Jamaica
	Saint Lawrence University	Canton
	Saint Thomas Aquinas College	Sparkhill
	Skidmore College	Saratoga Springs
	Southampton College	Southampton
	State University of New York at Buffalo	Buffalo
	Syracuse University	Syracuse
	The Cooper Union	New York
	Trocaire College	Buffalo
	Ulster County Community College	Stone Ridge
	University of Rochester	Rochester
	Vassar College	Poughkeepsie
	Wagner College	Staten Island
	Webb Institute of Naval Architecture	Glen Cove
	Westchester Community College	Valhalla
NC	Anson Technical Institute	Ansonville
	Appalachian State University	Boone
	Asheville Buncombe Technical Institute	Asheville
	Atlantic Christian College	Wilson
	Beaufort County Technical Institute	Washington
	Belmont Abbey College	Belmont
	Bennett College	Greensboro
	Bladen Technical Institute	Dublin
	Blue Ridge Technical Institute	Flat Rock
	Brevard College	Brevard
	Campbell College	Buies Creek
	Cape Fear Technical Institute	Wilmington
	Carteret Technical Institute	Morehead City
	Catawba College	Salisbury
	Catawba Valley Technical Institute	Hickory
	Central Carolina Technical Institute	Sanford
	Central Piedmont Community College	Charlotte
	Chowan College	Murfreesboro
	Cleveland County Technical Institute	Shelby
	Coastal Carolina Community College	Jacksonville
	College of the Albemarle	Elizabeth City
	Craven Community College	New Bern
	Davidson College	Davidson
	Davidson County Community College	Lexington
	Duke University	Durham
	Durham College	Durham
	East Carolina University	Greenville
	Elon College	Elon College
	Fayetteville State University	Fayetteville
	Fayetteville Technical Institute	Fayetteville
	Gardner Webb College	Boiling Springs
	Gaston College	Dallas
	Greensboro College	Greensboro
	Guilford College	Greensboro
	Guilford Technical Institute	Jamestown
	Halifax Community College	Weldon
	Haywood Technical Institute	Clyde
	High Point College	High Point
	Isothermal Community College	Spindale
	James Sprunt Institute	Kenansville
	Johnson C. Smith University	Charlotte

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Johnston Technical Institute	Smithfield
	Lees-McCrae College	Banner Elk
	Lenoir Community College	Kinston
	Lenoir-Rhyne College	Hickory
	Livingstone College	Salisbury
	Louisburg College	Louisburg
	Mars Hill College	Mars Hill
	Martin Community College	Williamston
	Mayland Technical Institute	Spruce Pine
	McDowell Technical Institute	Marion
	Meredith College	Raleigh
	Methodist College	Fayetteville
	Montreat-Anderson College	Montreat
	Mount Olive College	Mount Olive
	Nash Technical Institute	Rocky Mount
	North Carolina Agricultural and Technical State University	Greensboro
	North Carolina Central University	Durham
	North Carolina State University	Raleigh
	North Carolina Wesleyan College	Rocky Mount
	Pembroke State University	Pembroke
	Pfeiffer College	Misenheimer
	Piedmont Bible College	Winston-Salem
	Piedmont Technical Institute	Roxboro
	Pitt Technical Institute	Greenville
	Queens College	Charlotte
	Randolph Technical Institute	Asheboro
	Richmond Technical Institute	Hamlet
	Roanoke-Chowan Technical Institute	Ahoskie
	Robeson Technical Institute	Lumberton
	Rockingham Community College	Wentworth
	Rowan Technical Institute	Salisbury
	Saint Andrews Presbyterian College	Laurinburg
	Saint Augustine's College	Raleigh
	Saint Mary's College	Raleigh
	Salem College	Winston-Salem
	Sampson Technical Institute	Clinton
	Sandhills Community College	Carthage
	Shaw University	Raleigh
	Stanly Technical Institute	Albermarle
	Surry Community College	Dobson
	Technical Institute of Alamance	Burlington
	Tri-County Technical Institute	Murphy
	University of North Carolina at Chapel Hill	Chapel Hill
	University of North Carolina at Charlotte	Charlotte
	University of North Carolina at Greensboro	Greensboro
	University of North Carolina at Wilmington	Wilmington
	Wake Forest University	Winston-Salem
	Wake Technical Institute	Raleigh
	Warren Wilson College	Swannanoa
	Wayne Community College	Goldsboro
	Western Carolina University	Cullowhee
	Western Piedmont Community College	Morganton
	Wilkes Community College	Wilkesboro
	Wilson County Technical Institute	Wilson
	Wingate College	Wingate
	Winston-Salem State University	Winston-Salem

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
ND	Bismarck Junior College	Bismarck
	Dickinson State College	Dickinson
	Jamestown College	Jamestown
	Lake Region Junior College	Devils Lake
	Mary College	Bismarck
	Mayville State College	Mayville
	Minot State College	Minot
	North Dakota State School of Science	Wahpeton
	North Dakota State University-Main Campus	Fargo
	North Dakota State University-Bottineau	Bottineau
	Trinity Bible Institute	Ellendale
	University of North Dakota-Main Campus	Grand Forks
	University of North Dakota-Williston	Williston
OH	Antioch College	Yellow Springs
	Art Academy of Cincinnati	Cincinnati
	Bluffton College	Bluffton
	Capital University	Columbus
	Case Western Reserve University	Cleveland
	Central Ohio Technical College	Newark
	Central State University	Wilberforce
	Cincinnati Bible College	Cincinnati
	Cincinnati Technical College	Cincinnati
	Clark Technical College	Springfield
	Cleveland Institute of Art	Cleveland
	Cleveland Institute of Music	Cleveland
	Cleveland State University	Cleveland
	College of Mount St. Joseph on the Ohio	Cincinnati
	College of Steubenville	Steubenville
	College of Wooster	Wooster
	Columbus College of Art and Design	Columbus
	Columbus Technical Institute	Columbus
	Cuyahoga Community College	Cleveland
	Davis Junior College	Toledo
	Defiance College	Defiance
	Denison University	Granville
	Franklin University	Columbus
	Hebrew Union College	Cincinnati
	Heidelberg College	Tiffin
	Hiram College	Hiram
	Hocking Technical College	Nelsonville
	Jefferson County Technical Institute	Steubenville
	John Carroll University	Cleveland
	Josephinum College of Liberal Arts	Worthington
	Kent State University	Kent
	Kenyon College	Gambier
	Kettering College of Medical Arts	Kettering
	Lakeland Community College	Mentor
	Lima Technical College	Lima
	Lorain County Community College	Elyria
	Lutheran Theological Seminary	Columbus
	Malone College	Canton
	Marietta College	Marietta
	Marion Technical College	Marion
	Medical College of Ohio	Toledo
	Miami-Jacobs Junior College	Dayton
	Miami University	Oxford
	Mount Union College	Alliance
	Mount Vernon Nazarene College	Mount Vernon
	Muskingum Area Technical College	Zanesville
	Muskingum College	New Concord
	National Training and Operational Technology Center (EPA)	Cincinnati
	North Central Technical College	Mansfield

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Northwest Technical College	Archbold
	Notre Dame College	Cleveland
	Oberlin College	Oberlin
	Ohio Board of Regents-Technical Education Offerings	Columbus
	Ohio Dominican College	Columbus
	Ohio Northern University	Ada
	Ohio State University	Columbus
	Ohio University	Athens
	Ohio Wesleyan University	Delaware
	Owens Technical College	Perrysburg
	Saint John College of Cleveland	Cleveland
	Sinclair Community College	Dayton
	Stark Technical College	Canton
	Tiffin University	Tiffin
	United Theological Seminary	Dayton
	University of Cincinnati	Cincinnati
	University of Dayton	Dayton
	University of Toledo	Toledo
	Urbana College	Urbana
	Washington Technical College	Marietta
	Wittenberg University	Springfield
	Wright State University	Dayton
	Xavier University	Cincinnati
	Youngstown State University	Youngstown
OK	Bacone College	Muskogee
	Bartlesville Weslyan College	Bartlesville
	Bethany Nazarene College	Bethany
	Cameron University	Lawton
	Carl Albert Junior College	Poteau
	Central State University	Edmond
	Claremore Junior College	Claremore
	Connors State College	Warner
	East Central Oklahoma State University	Ada
	Eastern Oklahoma State College	Wilburton
	El Reno Junior College	El Reno
	Hillsdale Free Will Baptist College	Moore
	Midwest Christian College	Oklahoma City
	Murray State College	Tishomingo
	Northeastern Oklahoma Agricultural and Mechanical College	Miami
	Northeastern Oklahoma State University	Tahlequah
	Northern Oklahoma College	Tonkawa
	Northwesterm Oklahoma State University	Alva
	Oklahoma Baptist University	Shawnee
	Oklahoma Christian College	Oklahoma City
	Oklahoma City University	Oklahoma City
	Oklahoma Panhandle State University	Goodwell
	Oklahoma School of Business, Accountancy, Law and Finance	Tulsa
	Oklahoma State University-Main Campus	Stillwater
	Oklahoma State University-Oklahoma City	Oklahoma City
	Oral Roberts University	Tulsa
	Oscar Rose Junior College	Midwest City
	Phillips University	Enid
	Saint Gregory's College	Shawnee
	Sayre Junior College	Sayre
	Seminole Junior College	Seminole
	Southeastern Oklahoma State University	Durant
	South Oklahoma City Junior College	Oklahoma City
	Southwestern College	Oklahoma City
	Tulsa Junior College	Tulsa
	University of Oklahoma-Central Office	Norman

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	University of Oklanoma-Health Science Center	Oklahoma City
	University of Science and Arts of Oklanoma	Chickasha
	University of Tulsa	Tulsa
	Western Oklanoma State College	Altus
OR	Blue Mountain Community College	Pendleton
	Chemeketa Community College	Salem
	Clackamas Community College	Oregon City
	Clatsop Community College	Astoria
	Columbia Christian College	Portland
	Concordia College	Portland
	George Fox College	Newberg
	Judson Baptist College	Portland
	Lane Community College	Eugene
	Lewis and Clark College	Portland
	Linfield College	McMinnville
	Linn-Benton Community College	Albany
	Marylhurst Education Center	Marylhurst
	Mount Hood Community College	Gresham
	Multnomah School of the Bible	Portland
	Museum Art School	Portland
	Oregon State Higher Education District	
	Eastern Oregon State College	La Grande
	Oregon College of Education	Monmouth
	Oregon Institute of Technology	Klamath Falls
	Oregon State University	Corvallis
	Portland State University	Portland
	Southern Oregon State College	Ashland
	University of Oregon-Health Sciences Center	Portland
	Pacific University	Forest Grove
	Reed College	Portland
	Southwestern Oregon Community College	Coos Bay
	Treasure Valley Community College	Ontario
	Umpqua Community College	Rosenburg
	University of Portland	Portland
	Warner Pacific College	Portland
	Western Baptist Bible College	Salem
	Western Conservative Baptist Seminary	Portland
	Western Evangelical Seminary	Portland
	Williamette University	Salem
PA	Allegheny College	Meadville
	Allentown College of St. Francis De Sales	Center Valley
	Alliance College	Cambridge Springs
	Beaver College	Glenside
	Bloomsburg State College	Bloomsburg
	Bucks County Community College	Newton
	Butler County Community College	Butler
	Cabrini College	Radnor
	California State College	California
	Carlow College	Pittsburgh
	Carnegie-Mellon University	Pittsburgh
	Cedar Crest College	Allentown
	Chestnut Hill College	Philadelphia
	Cheyney State College	Cheyney
	Clarion State College	Clarion
	Community College of Allegheny County	Pittsburgh
	Community College of Beaver County	Monaca
	Community College of Philadelphia	Philadelphia
	Delaware Valley College of Science and Agriculture	Doylestown

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Dickinson College	Carlisle
	Drexel University	Philadelphia
	The Dropsie University	Philadelphia
	Duquesne University	Pittsburgh
	Eastern College	Saint Davids
	East Stroudsburg State College	East Stroudsburg
	Edinboro State College	Edinboro
	Franklin-Marshall College	Lancaster
	Gannon College	Erie
	Geneva College	Beaver Falls
	Gettysburg College	Gettysburg
	Gwynedd-Mercy College	Gwynedd Valley
	Harcum Junior College	Bryn Mawr
	Haverford College	Haverford
	Indiana University of Pennsylvania	Indiana
	Juniata College	Huntingdon
	Keystone Junior College	La Plume
	King's College	Wilkes-Barre
	Lafayette College	Easton
	La Roche College	Allison Park
	La Salle College	Philadelphia
	Lehigh University	Bethlehem
	Lincoln University	Lincoln University
	Lock Haven State College	Lock Haven
	Lycoming College	Williamsport
	Mansfield State College	Mansfield
	Marywood College	Scranton
	Mercyhurst College	Erie
	Millersville State College	Millersville
	Montgomery County Community College	Blue Bell
	Northeastern Christian Junior College	Villanova
	Pennsylvania State University	University Park
	Philadelphia College of Pharmacy and Science	Philadelphia
	Point Park College	Pittsburgh
	Reading Area Community College	Reading
	Saint Fidelis College	Herman
	Saint Francis College	Loretto
	Saint Joseph's College	Philadelphia
	Saint Vincent College	Latrobe
	Seton Hill College	Greensburg
	Slippery Rock State College	Slippery Rock
	Spring Garden College	Chestnut Hill
	Susquehanna University	Selinsgrove
	Swarthmore College	Swarthmore
	Temple University	Philadelphia
	University of Pennsylvania	Philadelphia
	University of Pittsburg	Pittsburgh
	University of Scranton	Scranton
	Ursinus College	Collegeville
	Villa Maria College	Erie
	Villanova University	Villanova
	Waynesburg College	Waynesburg
	West Chester State College	West Chester
	Westminster College	New Wilmington
	Widener College	Chester
	Wilkes College	Wilkes-Barre
	Williamsport Area Community College	Williamsport
	Wilson College	Chambersburg
PR	Inter American University of Puerto Rico	San German
	The Catholic University of Puerto Rico	Ponce
	University of Puerto Rico	Mayaguez
	University of Puerto Rico	Rio Pedras

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
RI	Brown University	Providence
	Providence College	Providence
	Roger Williams College	Bristol
	University of Rhode Island	Kingston
SC	Aiken Technical Education Center	Aiken
	Baptist College	Charleston
	Bob Jones University	Greenville
	Central Wesleyan College	Central
	Citadel Military College of South Carolina	Charleston
	Claflin College	Orangeburg
	Clemson University	Clemson
	Coastal Carolina College	Conway
	Coker College	Hartsville
	College of Charleston	Charleston
	Columbia College	Columbia
	Columbia Bible College	Columbia
	Converse College	Spartanburg
	Erskine College	Due West
	Florence-Darlington Technical College	Florence
	Francis Marion College	Florence
	Furman University	Greenville
	Greenville Technical College	Greenville
	Lander College	Greenwood
	Limestone College	Gaffney
	Morris College	Sumter
	Newberry College	Newberry
	North Greenville College	Tigerville
	Orangeburg-Calhoun Technical College	Orangeburg
	Piedmont Technical College	Greenwood
	South Carolina State College	Orangeburg
	Sumter Area Technical College	Sumter
	Tri County Technical College	Pendleton
	Trident Technical College	North Charleston
	University of South Carolina	Columbia
	University of South Carolina at Aiken	Aiken
	University of South Carolina at Beaufort	Beaufort
	University of South Carolina at Spartanburg	Spartanburg
	University of South Carolina at Union	Union
	Voorhees College	Denmark
	Winthrop College	Rock Hill
	Wofford College	Spartanburg
SD	Augustana College	Sioux Falls
	Black Hills State College	Spearfish
	Dakota Wesleyan University	Mitchell
	Freeman Junior College	Freeman
	National College of Business	Rapid City
	Northern State College	Aberdeen
	Presentation College	Aberdeen
	Sioux Falls College	Sioux Falls
	South Dakota School of Mines and Technology	Rapid City
	South Dakota State University	Brookings
	University of South Dakota-Springfield	Springfield
TN	Aquinas Junior College	Nashville
	Austin Peay State University	Clarksville
	Belmont College	Nashville
	Carson-Newman College	Jefferson City
	Chattanooga State Technical Community College	Chattanooga

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Christian Brothers College	Memphis
	Cleveland State Community College	Cleveland
	Columbia State Community College	Columbia
	Covenant College	Lookout Mountain
	Cumberland College	Lebanon
	David Lipscomb College	Nashville
	Dyersburg State Community College	Dyersburg
	East Tennessee State University	Johnson City
	Fisk University	Nashville
	Freed-Hardeman College	Henderson
	Free Will Baptist Bible College	Nashville
	George Peabody College for Teachers	Nashville
	Hiwassee College	Madisonville
	Jackson State Community College	Jackson
	King College	Bristol
	Knoxville College	Knoxville
	Lambuth College	Jackson
	LeMoyne-Owen College	Memphis
	Martin College	Pulaski
	Memphis State University	Memphis
	Middle Tennessee State University	Murfreesboro
	Milligan College	Milligan College
	Nashville State Technical Institute	Nashville
	Roane State Community College	Harriman
	Shelby State Community College	Memphis
	State Technical Institute at Memphis	Memphis
	Steed College	Johnson City
	Tennessee Technological University	Cookeville
	Tennessee Wesleyan College	Athens
	University of the South	Sewanee
	University of Tennessee	Knoxville
	University of Tennessee Center for Health Sciences	Memphis
	University of Tennessee at Martin	Martin
	University of Tennessee at Nashville	Nashville
	Vanderbilt University	Nashville
	Volunteer State Community College	Gallatin
	Walters State Community College	Morristown
TX	Abilene Christian University	Abilene
	Alvin Community College	Alvin
	Amarillo College	Amarillo
	American Technological University	Killeen
	Angelina College	Lufkin
	Angelo State University	San Angelo
	Austin College	Sherman
	Austin Presbyterian Technological Seminary	Austin
	Baylor College of Dentistry	Dallas
	Baylor College of Medicine	Houston
	Baylor University	Waco
	Bee County College	Beeville
	Blinn College	Brenham
	Brazosport College	Lake Jackson
	Cisco Junior College	Cisco
	Clarendon College	Clarendon
	College of the Mainland	Texas City
	Concordia Lutheran College	Austin
	Cooke County College	Gainesville
	Dallas Bible College	Dallas
	Dallas Christian College	Dallas
	Dallas County Community College District	
	Eastfield College	Mesquite
	El Centro College	Dallas
	Mountain View College	Dallas
	Richland College	Dallas

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Dallas Theological Seminary	Dallas
	Del Mar College	Corpus Christi
	DeVry Institute of Technology	Dallas
	East Texas Baptist College	Marshall
	East Texas State University	Commerce
	El Paso Community College	El Paso
	Frank Phillips College	Borger
	Galveston College	Galveston
	Grayson College	Denison
	Gulf Coast Bible College	Houston
	Hardin-Simmons University	Abilene
	Henderson County Junior College	Athens
	Houston Baptist University	Houston
	Houston Community College	Houston
	Howard College at Big Spring	Big Spring
	Howard Payne University	Brownwood
	Huston-Tillotson College	Austin
	Incarnate Word College	San Antonio
	Jacksonville College	Jacksonville
	Jarvis Christian College	Hawkins
	Kilgore College	Kilgore
	Lamar University	Beaumont
	Laredo Junior College	Laredo
	Lee College	Baytown
	Le Tourneau College	Longview
	Lon Morris College	Jacksonville
	Lubbock Christian College	Lubbock
	McLennan Community College	Waco
	McMurry College	Abilene
	Midland College	Midland
	Midwestern State University	Wichita Falls
	Navarro College	Corsicana
	North Harris County College	Houston
	North Texas State University	Denton
	Odessa College	Odessa
	Our Lady of the Lake University of San Antonio	San Antonio
	Pan American University	Edinburg
	Panola Junior College	Carthage
	Ranger Junior College	Ranger
	Rice University	Houston
	Saint Edward's University	Austin
	Sam Houston State University	Huntsville
	San Antonio College	San Antonio
	San Jacinto College	Pasadena
	Schreiner College	Kerrville
	Southern Bible College	Houston
	Southern Methodist University	Dallas
	South Plains College	Levelland
	South Texas College of Law	Houston
	Southwestern Assemblies of God College	Waxahachie
	Southwestern Baptist Theological Seminary	Fort Worth
	Southwestern Christian College	Terrell
	Southwestern Union College	Keene
	Southwestern University	Georgetown
	Southwest Texas State University	San Marcos
	Stephen F. Austin State University	Nacogdoches
	Tarleton State University	Stephenville
	Tarrant County Junior College-Northeast Campus	Hurst
	Tarrant County Junior College-Northwest Campus	Fort Worth
	Tarrant County Junior College-South Campus	Fort Worth
	Texarkana College	Texarkana
	Texas A & I University	Kingsville

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Texas A & I University-Corpus Christi	Corpus Christi
	Texas A & I University-Laredo	Laredo
	Texas A & M University-Main Campus	College Station
	Texas A & M University Moody College of Marine Sciences and Maritime Resources-	Galveston
	Texas Christian University	Fort Worth
	Texas College	Tyler
	Texas Lutheran College	Seguin
	Texas Southmost College	Brownsville
	Texas State Technical Institute-James Connally Campus	Waco
	Texas State Technical Institute-Mid-Continent Campus	Amarillo
	Texas State Technical Institute-Rio Grande Campus	Harlingen
	Texas Tech University	Lubbock
	Texas Wesleyan College	Fort Worth
	Texas Woman's University	Denton
	Trinity University	San Antonio
	Tyler Junior College	Tyler
	University of Dallas	Irving
	University of Houston-Main Campus	Houston
	University of Houston-Clear Lake City	Houston
	University of Houston-Victoria Campus	Victoria
	University of Texas-Arlington	Arlington
	University of Texas-Austin	Austin
	University of Texas at Dallas	Richardson
	University of Texas-El Paso	El Paso
	University of Texas Health Science Center at Dallas	Dallas
	University of Texas Health Science Center at Houston	Houston
	University of Texas Medical Branch at Galveston	Galveston
	University of Texas-San Antonio	San Antonio
	Vernon Regional Junior College	Vernon
	Victoria College	Victoria
	Weatherford College	Weatherford
	Western Texas College	Snyder
	West Texas State Universtiy	Canyon
	Wharton County Junior College	Wharton
	Wiley College	Marshall
UT	Brigham Young University	Provo
	Stevens Henager College	Ogden
	University of Utah	Salt Lake City
	Utah Higher Education System Office	
	University of Utah	Salt Lake City
	Utah State University	Logan
	Southern Utah State College	Cedar City
	Weber State College	Ogden
	College of Eastern Utah	Price
	Dixie College	Saint George
	Snow College	Ephraim
	Utah Technical College at Salt Lake City	Salt Lake City
	Westminster College	Salt Lake City

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
VT	Champlain College	Burlington
	Johnson State College	Johnson
	Lyndon State College	Lyndonville
	Marlboro College	Marlboro
	Middlebury College	Middlebury
	Norwich University	Northfield
	Saint Michael's College	Winooski
	School for International Training	Brattleboro
	Southern Vermont College	Bennington
	Trinity College	Burlington
	University of Vermont and State Agriculture College	Burlington
	Vermont Institute of Community Involvement	South Burlington
	Vermont Technical College	Randolph Center
	Windham College	Putney
VA	Averett College	Danville
	Bridgewater College	Bridgewater
	College of William and Mary	Williamsburg
	Eastern Mennonite College	Harrisonburg
	Eastern Virginia Medical School	Norfolk
	Emory and Henry College	Emory
	Ferrum College	Ferrum
	Hampton Institute	Hampton
	Institute of Textile Technology	Charlottesville
	J. Sargeant Reynolds Community College	Richmond
	Madison University	Harrisonburg
	Old Dominion University	Norfolk
	Radford College	Radford
	Randolph-Macon College	Ashland
	Randolph-Macon Woman's College	Lynchburg
	Saint Paul's College	Lawrenceville
	University of Virginia	Charlottesville
	Virginia Intermont College	Bristol
	Virginia Military Institute	Lexington
	Virginia Polytechnic Institute and State University	Blacksburg
	Virginia Wesleyan College	Norfolk
	Washington and Lee University	Lexington
	Wytheville Community College	Wytheville
WA	Bellevue Community College	Bellevue
	Big Bend Community College	Moses Lake
	Centralia College	Centralia
	Central Washington State College	Ellensburg
	Clark College	Vancouver
	Columbia Basin Community College	Pasco
	Cornish School of Allied Arts	Seattle
	Eastern Washington State College	Cheney
	Evergreen State College	Olympia
	Fort Steilacoom Community College	Tacoma
	Fort Wright College of the Holy Names	Spokane
	Gonzaga University	Spokane
	Grays Harbor College	Aberdeen
	Green River Community College	Auburn
	Highline Community College	Midway
	Lower Columbia College	Longview
	Lutheran Bible Institute of Seattle	Seattle
	Northwest College of the Assemblies of God	Kirkland
	Olympia Technical Community College	Olympia
	Olympic College	Bremerton
	Pacific Lutheran University	Tacoma
	Peninsula College	Port Angeles

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Seattle Community College District	
	North Seattle Community College	Seattle
	Seattle Community College-Central Campus	Seattle
	Seattle Community College-South Campus	Seattle
	Seattle University	Seattle
	Shoreline Community College	Seattle
	Skagit Valley College	Mount Vernon
	Tacoma Community College	Tacoma
	University of Puget Sound	Tacoma
	Walla Walla College	College Place
	Walla Walla Community College	Walla Walla
	Washington State Community College-District 5	
	Edmonds Community College	Lynnwood
	Everett Community College	Everett
	Washington State Community College-District 17	
	Spokane Falls Community College	Spokane
	Washington State University	Pullman
	Wenatchee Valley College	Wenatchee
	Western Washington State College	Bellingham
	Whatcom Community College	Bellingham
	Whitman College	Walla Walla
	Whitworth College	Spokane
	Yakima Valley College	Yakima
WV	Alderson Broaddus College	Phillippi
	Beckley College	Beckley
	Bethany College	Bethany
	Bluefield State College	Bluefield
	Concord College	Athens
	Davis and Elkins College	Elkins
	Glenville State College	Glenville
	Marshall University	Huntington
	Morris Harvey College	Charleston
	Parkersburg Community College	Parkersburg
	Potomac State College	Keyser
	Salem College	Salem
	West Liberty State College	West Liberty
	West Virginia Institute of Technology	Montgomery
	West Virginia University	Morgantown
	Wheeling College	Wheeling
WI	Alverno College	Milwaukee
	Beloit College	Beloit
	Blackhawk Technical Institute	Janesville
	Cardinal Stritch College	Milwaukee
	Carroll College	Waukesha
	Carthage College	Kenosha
	Concordia College	Milwaukee
	District One Technical Institute	Eau Claire
	Edgewood College	Madison
	Fox Valley Technical Institute	Appleton
	Gateway Technical Institute	Kenosha
	Holy Redeemer College	Waterford
	Institute of Paper Chemistry	Appleton
	Lakeshore Technical Institute	Cleveland
	Lawrence University	Appleton
	Madison Area Technical College	Madison
	Madison Business College	Madison
	Marian College of Fond Du Lac	Fond Du Lac
	Marquette University	Milwaukee
	Mid-State Technical Institute	Wisconsin Rapids
	Milton College	Milton

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Milwaukee Area Technical College	Milwaukee
	Moraine Park Vocational, Technical and Adult Education Institute	Fond Du Lac
	Mount Mary College	Milwaukee
	Mount Senario College	Ladysmith
	Nicolet College and Technical Institute	Rhinelander
	North Central Technical Institute	Wausau
	Northeast Wisconsin Technical Institute	Green Bay
	Northland College	Ashland
	Ripon College	Ripon
	Saint Norbert College	De Pere
	Silver Lake College	Manitowoc
	Southwest Wisconsin Vocational-Technical Institute	Fennimore
	University of Wisconsin-Green Bay	Green Bay
	University of Wisconsin-Madison	Madison
	University of Wisconsin-Milwaukee	Milwaukee
	University of Wisconsin-System Office	Madison
	Viterbo College	La Crosse
	Waukesha County Technical Institute	Pewaukee
	Western Wisconsin Technical Institute	La Crosse
WY	Casper College	Casper
	Eastern Wyoming College	Torrington
	Laramie County Community College	Cheyenne
	Northwest Community College	Powell
	Sheridan College	Sheridan
	University of Wyoming	Laramie
	Western Wyoming Community College	Rock Springs